

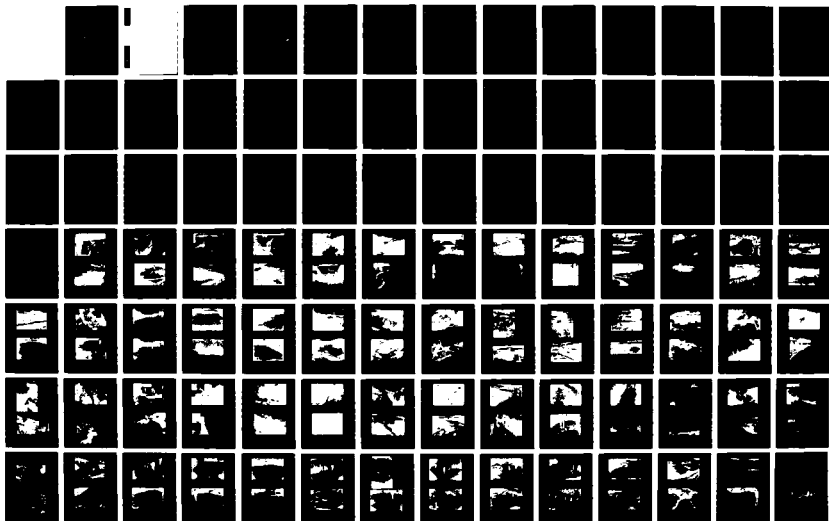
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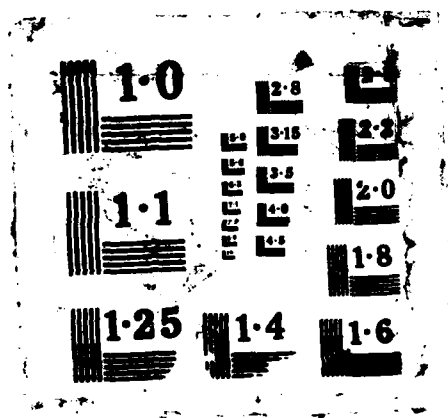
MULTIPLE-PURPOSE PROJECT LITTLE BLUE RIVER BASIN LITTLE 1/2
BLUE RIVER MISSOU. (U) CORPS OF ENGINEERS KANSAS CITY
NO KANSAS CITY DISTRICT V ANDERSON ET AL. FEB 86

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(Report)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER APPENDIX IV to the Longview Lake, Missouri Operation & Maintenance Manual	2. GOVT ACCESSION NO. ADA185188	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MULTIPLE-PURPOSE PROJECT; LITTLE BLUE RIVER BASIN; LITTLE BLUE RIVER, MO; LONGVIEW LAKE, OPERATION AND MAINTENANCE MANUAL; APPENDIX IV, VOLUMES ONE & TWO CONSTRUCTION FOUNDATION REPORT		5. TYPE OF REPORT & PERIOD COVERED 12 Sep 79 to 16 Oct 82
7. AUTHOR(s) Mr. Victor Anderson - Project Geologist Mr. William F. Lowe - Project Geologist		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Geology Section (CEMRK-ED-FG) Foundation and Materials Branch (CEMRK-ED-F) Kansas City District, US Army Corps of Engineers 601 E. 12th Street; Kansas City, MO 64106-2896		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS O&M Manuals Unit, Est. & Spec. Section (CEMRK-ED-DE) Design Branch (CEMRK-ED-D) Kansas City District, US Army Corps of Engineers 601 E. 12th Street; Kansas City, MO 64106-2896		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PB-2B and ER 1110-1-1801 Change 2 dated 1 Apr 83
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		13. NUMBER OF PAGES Volume 1 = 123
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Control Determination: This report conforms to the intent of the exempt report categories as set forth in AR 335-15 and under the paragraph 7-2y of the AR.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Volume One (of 2 volumes) Construction Foundation Report		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this report is to provide a record of foundation conditions encountered during construction and methods used to adapt to these conditions. This information is a part of the permanent collection of project engineering data required by ER 1110-1-1801, change 2, dated 1 April 1983.		

OPERATION AND MAINTENANCE MANUAL

LONGVIEW LAKE

LITTLE BLUE RIVER, MISSOURI

APPENDIX IV

CONSTRUCTION FOUNDATION REPORT

VOLUME ONE

February 1986



DEPARTMENT OF THE ARMY

KANSAS CITY DISTRICT, CORPS OF ENGINEERS

KANSAS CITY, MISSOURI

OPERATION AND MAINTENANCE MANUAL
LONGVIEW LAKE
LITTLE BLUE RIVER, MISSOURI

APPENDIX IV
CONSTRUCTION FOUNDATION REPORT
VOLUME ONE

TABLE OF CONTENTS

<u>PARAGRAPH</u>	<u>TITLE</u>	<u>PAGE NUMBER</u>
CHAPTER 1		
INTRODUCTION		
1-01	Location and Description	IV-I-1-1
1-02	Construction Authority	IV-I-1-1
1-03	Purpose of Report	IV-I-1-1
1-04	Contracts and Supervision	IV-I-1-2
1-05	Quality Control	IV-I-1-3
CHAPTER 2		
FOUNDATION EXPLORATIONS		
2-01	Investigations Prior to Construction	IV-I-2-1
2-02	Investigations During Construction	IV-I-2-2
CHAPTER 3		
GEOLOGY		
3-01	Regional Geology and Physiography	IV-I-3-1
3-02	Site Geology	IV-I-3-1
3-03	Description of Overburden	IV-I-3-1
3-04	Bedrock Stratigraphy	IV-I-3-1
3-05	Bedrock Structure, Jointing	IV-I-3-3
3-06	Bedrock Weathering	IV-I-3-4
3-07	Solution Activity	IV-I-3-4
3-08	Ground Water	IV-I-3-5
3-09	Engineering Characteristics of Overburden Materials	IV-I-3-5
3-10	Engineering Characteristics of Bedrock Materials	IV-I-3-5
3-11	Unusual or Unanticipated Geologic Conditions Encountered During Construction	IV-I-3-5
CHAPTER 4		
SPECIAL DESIGN CONSIDERATIONS		
4-01	Design Considerations	IV-I-4-1

TABLE OF CONTENTS--cont'd.

<u>PARAGRAPH</u>	<u>TITLE</u>	<u>PAGE NUMBER</u>
CHAPTER 5		
EXCAVATION PROCEDURES FOR COMPONENT PARTS		
5-01	Excavation Grades	IV-I-5-1
5-02	Dewatering Provisions	IV-I-5-1
5-03	Overburden Excavation	IV-I-5-1
5-04	Rock Excavation	IV-I-5-1
5-05	Line Drilling and Presplitting	IV-I-5-1
5-06	Foundation Preparation	IV-I-5-2
CHAPTER 6		
FOUNDATION ANCHORS AND ROCK BOLTS		
6-01	Foundation Anchors and Rock Bolts	IV-I-6-1
CHAPTER 7		
CHARACTER OF FOUNDATION		
7-01	Foundation Surface	IV-I-7-1
7-02	Condition of Foundation Soil or Rock	IV-I-7-1
7-03	Ground Water	IV-I-7-2
CHAPTER 8		
FOUNDATION TREATMENT		
8-01	Curtain Grouting	IV-I-8-1
8-02	Drainage Provisions	IV-I-8-1
8-03	Foundation Compaction or Consolidation	IV-I-8-2
8-04	Dental Concrete and Gravity Grouting	IV-I-8-2
8-05	Instrumentation	IV-I-8-2
CHAPTER 9		
POSSIBLE FUTURE PROBLEMS		
9-01	Conditions That Could Produce Problems	IV-I-9-1
CHAPTER 10		
OIL WELL PLUGGING		
10-01	Oil Well Plugging	IV-I-10-1

TABLE OF CONTENTS--cont'd.

DRAWINGS

(The following drawings, plate Nos. 1 thru 108, are bound separately as VOLUME TWO of this report)

<u>PLATE NO.</u>	<u>TITLE</u>	<u>FILE NO.</u>
1	Location and Vicinity	RBL-3-1101
2	General Plan	RBL-3-1102
3	Embankment Plan and Alinement Data	RBL-3-1103
4	Typical Embankment Sections	RBL-3-1104
5	Typical Embankment Sections, Existing Sever Profile and Construction Details	RBL-3-1105
6	General Plan or Excavation	RBL-3-1106
7	Outlet Works Plan of Excavation	RBL-3-1107
8	Approach Structures Excavation Plan, Profile and Sections	RBL-3-1108
9	Stilling Basin and Sever Excavation Plan and Profile	RBL-3-1109
10	Outlet Works Excavation Sections	RBL-3-1110
11	Outlet Works Backfill Plan and Profile	RBL-3-1111
12	Stilling Basin Backfill Profile and Sections	RBL-3-1112
13	Sever Relocation and Conduit Details	RBL-3-1113
14	Dam Axis and Cutoff Trench Profile	RBL-3-1114
15	Outlet Works Plan and Profile	RBL-3-1115
16	Embankment Observation Devices, Installation Details	RBL-3-1116
17	Approach Structures Plan and Elevations	RBL-3-1117
18	Intake Tower Elevations	RBL-3-1118
19	Intake Tower Concrete Dimensions	RBL-3-1119
20	Conduit Monoliths 2 through 26	RBL-3-1120
21	Logs of Detached Borings	RBL-3-1121
22	Logs of Detached Borings	RBL-3-1122
23	Logs of Detached Borings	RBL-3-1123
24	Sever Encasement Sever Manhole, Monolith 30	RBL-3-1124
25	Stilling Basin Plan and Section	RBL-3-1125
26	General Geologic Column and Legend	RBL-3-1126
27	Dam Site Area Plan of Explorations	RBL-3-1127
28	Outlet Work: Plan of Explorations	RBL-3-1128
29	Outlet Works, Approach and Outlet Channels, Logs of Explorations and Plan of Explorations	RBL-3-1129
30	Outlet Works, Approach and Outlet Channels, Geologic Sections and Detached Borings	RBL-3-1130
31	Profile Along Dam Axis Logs of Explorations	RBL-3-1131
32	Spillway Profile and Sections	RBL-3-1132
33	Logs of Explorations Left and Right Abutments	RBL-3-1133
34	Logs of Detached Borings Dam Site Area	RBL-3-1134
35	Logs of Detached Borings Dam Site Area	RBL-3-1135
36	Logs of Detached Borings Dam Site Area	RBL-3-1136
37	Logs of Detached Borings Dam Site Area	RBL-3-1137
38	Logs of Detached Borings Dam Site Area	RBL-3-1138
39	Logs of Detached Borings Dam Site Area	RBL-3-1139

TABLE OF CONTENTS--cont'd.

DRAWINGS--cont'd.

<u>PLATE NO.</u>	<u>TITLE</u>	<u>FILE NO.</u>
40	Borrow Area Plan of Explorations and Detached Borings	RBL-3-1140
41	Logs of Detached Borings Borrow Area	RBL-3-1141
42	Logs of Detached Borings Borrow Area	RBL-3-1142
43	Curtain Grouting Plan and Profile Right Abutment	RBL-3-1143
44	Curtain Grouting Plan and Profile - Valley and Conduit Foundation Grouting Detail	RBL-3-1144
45	Curtain Grouting Plans and Profiles Left Abutment and Far Left Abutment	RBL-3-1145
46	Grout Curtain Profile, Line C, on Dam Axis Station 84+00 to Station 85+05	RBL-3-1146
47	Grout Curtain Profile, Line C, on Dam Axis Station 85+05 to Station 86+85	RBL-3-1147
48	Grout Curtain Profile, Line C, on Dam Axis Station 86+85 to Station 88+65	RBL-3-1148
49	Grout Curtain Profile, Line C, on Dam Axis Station 88+65 to Station 92+05	RBL-3-1149
50	Grout Curtain Profile, Line C, on Dam Axis Station 92+05 to Station 95+15	RBL-3-1150
51	Grout Curtain Profile, Line C, on Dam Axis Station 95+15 to Station 98+40	RBL-3-1151
52	Grout Curtain Profile, on Line C, Dam Axis Station 98+40 to Station 100+20	RBL-3-1152
53	Grout Curtain Profile, Line C, on Dam Axis Station 100+20 to Station 101+95	RBL-3-1153
54	Grout Curtain Profile, Line C, on Dam Axis Station 101+95 to Station 103+70	RBL-3-1154
55	Grout Curtain Profile, Line C, on Dam Axis Station 103+70 to Station 105+45	RBL-3-1155
56	Grout Curtain Profile, Line C, on Dam Axis Station 105+45 to Station 107+15	RBL-3-1156
57	Grout Curtain Profile, Line C, on Dam Axis Station 107+15 to Station 108+80	RBL-3-1157
58	Grout Curtain Profile, Line C, on Dam Axis Station 108+80 to Station 110+45	RBL-3-1158
59	Grout Curtain Profile, Line C, on Dam Axis Station 110+45 to Station 111+30	RBL-3-1159
60	Grout Curtain Profile, Line C, on Dam Axis Station 111+30 to Station 112+00	RBL-3-1160
61	Grout Curtain Profile, Line A, 10 Feet Downstream of Centerline Station 86+25 to Station 87+35	RBL-3-1161
62	Grout Curtain Profile, Line A, 10 Feet Downstream of Centerline Station 87+35 to Station 89+10	RBL-3-1162

TABLE OF CONTENTS--cont'd.

DRAWINGS--cont'd.

<u>PLATE NO.</u>	<u>TITLE</u>	<u>FILE NO.</u>
63	Grout Curtain Profile, Line A, 10 Feet Downstream of Centerline Station 89+10 to Station 89+65 and Station 100+05 to Station 101+65	RBL-3-1163
64	Grout Curtain Profile, Line A, 10 Feet Downstream of Centerline Station 101+65 to Station 102+70	RBL-3-1164
65	Grout Curtain Profile, Line A, 10 Feet Downstream of Centerline Station 102+70 to Station 103+85	RBL-3-1165
66	Grout Curtain Profile, Line B, 10 Feet Upstream of Centerline Station 86+20 to Station 87+45	RBL-3-1166
67	Grout Curtain Profile, Line B, 10 Feet Upstream of Centerline Station 87+45 to Station 89+25	RBL-3-1167
68	Grout Curtain Profile, Line B, 10 Feet Upstream of Centerline Station 89+25 to Station 89+65, Right Abutment and Station 100+05 to Station 101+75, Left Abutment	RBL-3-1168
69	Grout Curtain Profile, Line B, 10 Feet Upstream of Centerline Station 101+75 to Station 103+50	RBL-3-1169
70	Grout Curtain Profile, Line B, 10 Feet Upstream of Centerline Station 103+50 to Station 103+85	RBL-3-1170
71	Summary of Grouting	RBL-3-1171
72	Outlet Works Foundation Map Station 44+50 to Station 46+30	RBL-3-1172
73	Outlet Works Foundation Map Station 46+30 to Station 49+80	RBL-3-1173
74	Outlet Works Foundation Map Station 49+80 to Station 53+30	RBL-3-1174
75	Outlet Works Foundation Map Station 53+30 to Station 55+44.25	RBL-3-1175
76	Cutoff Trench Foundation Map, Right Abutment, Station 86+00 to Station 87+30	RBL-3-1176
77	Cutoff Trench Foundation Map, Right Abutment, Station 87+30 to Station 89+10	RBL-3-1177
78	Cutoff Trench Foundation Map, Right Abutment, Station 89+10 to Station 90+85	RBL-3-1178
79	Cutoff Trench Foundation Map, Right Abutment, Station 90+85 to Station 92+95	RBL-3-1179
80	Cutoff Trench Foundation Map, Right Abutment, Station 92+95 to Station 94+75	RBL-3-1180
81	Cutoff Trench Foundation Map, Right Abutment, Station 94+75 to Station 96+55	RBL-3-1181

TABLE OF CONTENTS--cont'd.

DRAWINGS--cont'd.

<u>PLATE NO.</u>	<u>TITLE</u>	<u>FILE NO.</u>
82	Cutoff Trench Foundation Map, Right Abutment, Station 96+55 to Station 98+35	RBL-3-1182
83	Cutoff Trench Foundation Map, Left Abutment, Station 98+35 to Station 100+13	RBL-3-1183
84	Cutoff Trench Foundation Map, Left Abutment, Station 100+13 to Station 102+00	RBL-3-1184
85	Cutoff Trench Foundation Map, Left Abutment, Station 102+00 to Station 103+80	RBL-3-1185
86	Cutoff Trench Final Cross Sections Station 86+46 to Station 87+15	RBL-3-1186
87	Cutoff Trench Final Cross Sections Station 87+25 to Station 102+30	RBL-3-1187
88	Cutoff Trench Final Cross Sections Station 02+37 to Station 103+85	RBL-3-1188
89	Embankment at Completion of Stage I	RBL-3-1189
90	Embankment Plan and Alignment Data	RBL-3-1190
91	Typical Embankment Sections	RBL-3-1191
92	Typical Embankment Sections	RBL-3-1192
93	Typical Sections and Details	RBL-3-1193
94	Diversion and Closure Plans and Sections	RBL-3-1194
95	Dam Axis Profile and Miscellaneous Sections and Details	RBL-3-1195
96	Top of Dam and Slope Protection Details	RBL-3-1196
97	Embankment Drainage Schedule, Sections and Details	RBL-3-1197
98	Stilling Basin Plan, Profile, Sections and Details	RBL-3-1198
99	Spillway Plan, Profile and Sections, Approach Channel Profile and Sections	RBL-3-1199
100	Elm Avenue Dike, Emergency Access Lane and Pipe Gate Details	RBL-3-1200
101	Left Abutment and Embankment Topography	RBL-3-1201
102	Right Abutment Plan of Excavation and Sections	RBL-3-1202
103	Right Abutment Upstream Impervious Clay Blanket Plan and Sections	RBL-3-1203
104	Embankment Observation Devices, Plan and Sections	RBL-3-1204
105	Embankment Observation Devices, Installation Details	RBL-3-1205
106	Plan and Elevation Service Bridge	RBL-3-1206
107	TABLES 1 & 2 Shot Data - LONGVIEW DAM, Stage I Blasting	RBL-3-1207
108	TABLE 3 Shot Data - LONGVIEW DAM, Stage II Blasting	RBL-3-1208

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>OUTLET WORKS FOUNDATION STAGE I</u>		
1	4 Dec 79, Left side outlet works excavation Station 50+77 to Station 50+87. Pleasanton Formation zones D and E.	#1
2	4 Dec 79, Right side outlet works excavation Station 50+86. Pleasanton Formation zone E.	#3
3	4 Dec 79, Look right and downstream outlet works excavation. Station 51+14 to Station 51+33. Dozer blade mark.	#4
4	4 Dec 79, Look left and downstream. Outlet works excavation. Station 51+14 to Station 51+33. Dozer blade mark.	#5
5	4 Dec 79, Look downstream. Outlet works excavation at Station 51+20. Pleasanton Formation zone E.	#6
6	4 Dec 79, Look left upstream. Outlet works excavation at Station 51+54. Pleasanton Formation zone E.	#7
7	4 Dec 79, On right side at Station 51+40. Look upstream. Note NX core hole AC-221. Placing lean concrete in background.	#8
8	4 Dec 79, at Station 51+50. Look left and downstream. Pleasanton zone E.	#9
9	4 Dec 79, at Station 51+55. Look left and downstream. Pleasanton zone E.	#10
10	4 Dec 79, Track mounted "roto mill" used to excavate final foundation surface.	#13
11	4 Dec 79, Track mounted "roto mill" used to excavate final foundation surface.	#28
12	5 Dec 79, Station 52+10 Centerline look left and downstream. Pleasanton Formation zone E.	#14
13	5 Dec 79, Station 52+35 Centerline look left and downstream. Pleasanton Formation zone E.	#16
14	5 Dec 79, Station 52+48 left side. Look right and downstream. Pleasanton Formation zone E.	#17
15	5 Dec 79, Station 52+75 right side. Look left and upstream. Pleasanton Formation zone E.	#18
16	5 Dec 79, Station 52+85 Centerline look right downstream. Pleasanton Formation zone E.	#19
17	5 Dec 79, Station 52+90 Centerline look downstream. Pleasanton Formation zone E.	#23
18	6 Dec 79, Station 53+20 Centerline look downstream. Pleasanton Formation zone E.	#25
19	6 Dec 79, at Station 53+40 Centerline look left and downstream. Pleasanton Formation zone E.	#26

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>OUTLET WORKS FOUNDATION STAGE I</u>		
20	6 Dec 79, at right wall Station 53+40. Look left and downstream. Pleasanton Formation zone E.	#27
21	6 Dec 79, at left side Station 54+10. Look right and upstream. Placing lean concrete.	#28
22	6 Dec 79, at right side Station 53+95. Look left. Pleasanton Formation zone E.	#29
23	6 Dec 79, at left side Station 54+00. Look right.	#30
24	7 Dec 79, at right side Station 51+00. Look left and downstream. Placing second layer of lean concrete.	#32
25	18 Feb 80, view of right abutment	#33
26	5 Mar 80, look west at slide on left side outlet works excavation Station 55+00+ to Station 57+50+. Slide occurred 18 Nov 79 estimated volume 3900+ CY.	#57
27	24 Mar 80, look west at slides on left side outlet works excavation near dam. Centerline slides occurred 23 Mar 80.	#98
28	9 April 80, at Station 48+75 Centerline look downstream. Pleasanton Formation zone D. Final foundation surface.	#112
29	9 April 80, at Station 46+15 Centerline look downstream. Pleasanton Formation zone D.	#114
30	9 April 80, at Station 46+47 Centerline look downstream. Pleasanton Formation zone D.	#115
31	9 April 80, at Station 47+48 Centerline look downstream. Pleasanton Formation zone D.	#116
32	9 April 80, at Station 48+49 Centerline look downstream. Pleasanton Formation zone D.	#117
33	10 April 80, at Station 46+32 Centerline look upstream. Pleasanton Formation zone D.	#119
34	16 April 80, rock saw used for vertical cuts in intake tower area.	#123
35	22 April 80, at Station 45+97 Centerline look upstream at right side. Pleasanton Formation zone C.	#134
36	22 April 80, at Station 45+97 Centerline look upstream at left side, rock saw working in background.	#135
37	22 May 80, at Station 55+40 Centerline look upstream. Pleasanton Formation zone E.	#165
38	1 June 80, Camera at Station 55+80 range 90' right. Look upstream and left.	#111

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>OUTLET WORKS FOUNDATION STAGE I</u>		
39	24 June 80, Camera at O.W. Station 44+50. Look downstream at outlet work.	#228
40	10 July 80, Camera at O.W. Station 54+30+ range 78' right. Look downstream at concrete encased temporary sewer, "inverted siphon," before new sewer construction.	#642
41	10 July 80, Camera at O.W. Station 54+70+ range 78' right. Look upstream at "inverted siphon," before new sewer construction.	#643
42	27 Aug 80, at O.W. Station 54+50 range 70'+ right. Look downstream and right at sewer foundation. Pleasanton Formation zone E.	#309
43	19 Sep 80, at O.W. Station 44+00+. Look D/S at intake tower.	#329
44	23 Sep 80, view of left abutment.	#235
45	23 Sep 80, view of right abutment.	#236
46	23 Sep 80, Camera at O.W. Station 56+00+, range 150' right. Look upstream at sewer line construction.	#223
47	3 Nov 80, Camera at O.W. Station 44+80+, range 60' left. Look east. Backfill around intake tower.	#261
48	1 Dec 80, look west at slides on left side of outlet works excavation. This is same area of slides which occurred on 23 Mar 80. See Photo 27.	#444
49	17 Feb 81, Camera at O.W. Station 55+50+, range 90'+ right. Look west at repaired slide area. See also photo 26.	#531
50	28 April 81, O.W. Station 51+25 on left side. Look downstream foundation cleanup prior to placement of pervious drain material. Pleasanton Formation zone E.	#647
51	28 April 81, O.W. Station 51+25 on left side. Look downstream. Foundation cleanup. Pleasanton Form, zone E.	#645
52	1 June 81, O.W. Station 52+35 on right side. Look downstream. Foundation cleanup. Pleasanton Form, zone E.	#706
53	1 June 81, O.W. Station 48+00+ on right side. Look downstream. Placing pervious drain backfill material.	#707
54	6 July 81, O.W. Station 47+20+ range 180'+ right. Look NW. Foundation cleanup of old sewer excavation. Pleasanton Formation zones A and B.	#858

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>OUTLET WORKS FOUNDATION STAGE I</u>		
55	17 July 81, O.W. Station 55+10+, range 50'+ right. Look upstream at temporary, concrete encased, 20-inch diameter, sewer line, "inverted siphon," after new sewer construction.	#875
56	17 July 81, O.W. Station 54+51+, range 80'+ right. Look left and downstream at "inverted siphon," after new sewer construction.	#903
57	17 July 81, O.W. Station 55+00+, range 40'+ right. Look upstream and "inverted siphon." Men covering pipe with filter cloth.	#905
58	17 July 81, O.W. Station 54+67+, range 40'+ right. Look downstream at "inverted siphon." Men covering pipe with filter cloth.	#906
59	20 July 81, O.W. Station 54+70+, range 80'+ right. Look upstream and left. Cleanup on upstream side of new sewer.	#911
60	20 July 81, O.W. Station 54+25+ Centerline look right at cleanup on upstream side of new sewer.	#910
61	21 July 81, O.W. Station 54+30 Centerline look right. Men placing pervious backfill on upstream side of new sewer.	#913
62	21 July 81, O.W. Station 55+05+, range 60'+ right. Look left at outlet works.	#916
<u>CUTOFF TRENCH FOUNDATION STAGE I</u>		
63	10 June 80, cutoff trench Station 89+85, range 50'+ D/S. Look upstream. Men placing pervious drain.	#2
64	10 June 80, cutoff trench Station 90+00 Centerline look southeast. Placing pervious and impervious.	#9
65	10 June 80, cutoff trench Station 90+70, range 10'+ D/S. Look southeast. Preparing for placement of pervious drain.	#22
66	10 June 80, cutoff trench Station 90+80, range 50'+ D/S. Look southeast. Placing pervious drain material.	#88
67	10 June 80, cutoff trench Station 89+50, range 10'+ D/S. Look west. Preparing for placement of pervious.	#23
68	10 July 80, cutoff trench Station 89+65. Look at downstream slope. Pleasanton zone B shale.	#235

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>CUTOFF TRENCH FOUNDATION STAGE I</u>		
69	12 July 80, cutoff trench Station 89+40. Look at downstream slope. Pleasanton zone B shale.	#238
70	30 July 80, look west at embankment left abutment.	#350
71	30 July 80, look west at left abutment in background with right abutment in foreground.	#351
72	1 Aug 80, Camera at dam Station 88+20, range 200' upstream. Look downstream. Placing backfill against Sniabar limestone.	#212
73	14 Aug 80, Station 85+10, range 460' upstream. Look downstream middle creek limestone.	#224
74	14 Aug 80, Station 85+10, range 460' upstream. Look downstream, placing "dental concrete" on Middle Creek Ls.	#217
75	14 Aug 80, Station 85+10, range 460' upstream. Look downstream. Slush grouting Middle Creek Ls.	#215
76	1 Oct 80, right abutment Station 87+70+. Look east at Bethany Falls limestone and Hushpuckney Shale.	#335
77	13 Oct 80, right abutment Station 89+00. Look east at Pleasanton zone A sandstone.	#347
78	13 Oct 80, right abutment Station 89+00. Look east at Pleasanton zone A sandstone.	#348
79	17 Nov 80, look upstream at outlet works construction.	#403
80	18 Nov 80, look downstream at outlet works construction.	#426
81	19 Nov 80, Station 88+40. Look downstream at Sniabar limestone.	#431
82	15 Dec 80, Station 87+80. Look downstream at Bethany Falls LS and Hushpuckney Shale.	#467
83	15 Dec 80, Station 87+80. Joints in lower 2 1/2 feet of Hushpuckney Shale.	#469
84	15 Dec 80, Station 87+80+. Look upstream Bethany Falls limestone and Hushpuckney Shale.	#470
85	22 Jan 81, construction of bridge over outlet channel.	#517
86	19 Mar 81, Station 87+85 right abutment look at downstream corner of cutoff trench. Bethany Falls limestone and Hushpuckney Shale.	#591
87	4 Apr 81, Station 97+95. From old 48-inch sewer look east at 6-inch core hole AC-21. Pleasanton zone D.	#613

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>CUTOFF TRENCH FOUNDATION STAGE I</u>		
88	4 Apr 81, Station 97+83. Look east and downstream at Pleasanton zone D.	#615
89	4 April 81, Station 97+15. Look east Pleasanton zone D.	#616
90	4 Apr 81, Station 97+65. Look west at old 48-inch sewer pipe at Station 97+95.	#617
91	4 Apr 81, Station 97+65. Look west at old 48-inch sewer.	#618
92	4 Apr 81, Station 97+83. Look upstream and east.	#619
93	4 Apr 81, Station 97+83. Look upstream Pleasanton zone D.	#620
94	4 Apr 81, Station 97+75, range 20 U/S. Look upstream at calcareous nodules in Pleasanton zone D.	#622
95	4 Apr 81, Station 96+90. Look upstream Pleasanton zone D.	#624
96	4 Apr 81, Station 97+25. Look east Pleasanton zone D.	#623
97	4 Apr 81, Station 96+60. Look upstream and left Pleasanton zone D.	#625
98	4 Apr 81, Station 95+75. Look west Pleasanton zone D.	#626
99	4 Apr 81, Station 96+50. Look southeast Pleasanton zone D.	#627
100	4 Apr 81, Station 95+75. Look southwest Pleasanton zone D.	#628
101	4 Apr 81, Station 96+25. Look east Pleasanton zone D.	#629
102	4 Apr 81, Station 96+20. Look northeast.	#630
103	2 May 81, Station 98+70. Look west at base of Pleasanton zone C.	#651
104	2 May 81, Station 98+70. Look west at base of Pleasanton zone C.	#652
105	2 May 81, Station 98+70. Look west at base of Pleasanton zone C.	#653
106	6 July 81, look downstream at foundation cleanup of old sewer.	#654
107	13 July 81, look downstream along right side of outlet works.	#869
108	14 July 81, Station 98+20. Look east Pleasanton zone D.	#870
109	14 July 81, Station 98+00. Look west toward conduit.	#871
110	14 July 81, Station 97+80. Look west toward conduit.	#872

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>CUTOFF TRENCH FOUNDATION STAGE I</u>		
111	22 July 81, Station 98+80. Look downstream along left side of conduit.	#922
112	22 July 81, Station 99+05. Look downstream along left side of conduit.	#924
113	24 July 81, Station 99+20. Look west contact of Pleasanton zone B shale and zone C argillaceous limestone.	#929
114	30 July 81, Station 99+50. Look upstream Pleasanton zone B.	#943
115	30 July 81, Station 99+43+. Look west Pleasanton zone B.	#944
116	30 July 81, Station 99+43+. Look west Pleasanton zone B.	#945
117	30 July 81, Station 99+43+. Look west Pleasanton zone B.	#946
118	30 July 81, Station 99+43+. Look west Pleasanton zone B.	#947
119	18 Aug 81, Station 99+80. Look west Pleasanton zone B.	#1021
120	19 Aug 81, Station 99+95. Look upstream Pleasanton zone B.	#1023
121	19 Aug 81, Station 99+95. Look downstream Pleasanton zone B.	#1024
<u>CUTOFF TRENCH AND EMBANKMENT FOUNDATION STAGE I</u>		
122	19 Aug 81, Station 99+75 range 30' U/S. Look downstream.	#1025
123	19 Aug 81, Station 99+70 Centerline Look upstream subcrop of Pleasanton zone B.	#1026
124	26 Aug 81, Station 99+60, range 30' U/S. Look downstream.	#1038
125	27 Aug 81, Station 99+75. Look west Pleasanton zones A and B.	#1011
126	4 Sep 81, Station 100+10+, range 30' U/S. Look downstream Lt. Abut. Sand filter in background.	#1055
127	14 Sep 81, Station 100+15. Look west Pleasanton zone A sandstone.	#1085
128	14 Sep 81, Station 100+15. Look west Pleasanton zone A sandstone.	#1086
129	20 Sep 81, Station 100+20. Look west at Sniabar limestone, Mound City shale and Critzer limestone.	#1107
130	20 Sep 81, Station 100+15. Look southwest at top of Critzer limestone.	#1108
131	21 Sep 81, look downstream intake tower.	#1111

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>CUTOFF TRENCH AND EMBANKMENT FOUNDATION STAGE I</u>		
132	23 Sep 81, Station 100+50 look west Sniabar limestone fill concrete U/S side of cutoff trench.	#1117
133	23 Sep 81, Station 100+50 look west Sniabar limestone.	#1118
134	30 Sep 81, Station 100+75. Look upstream Middle Creek limestone.	#1131
135	2 Oct 81, Station 100+75. Look downstream slickensides in Ladore shale.	#1132
136	3 Oct 81, Station 100+60, range 200' U/S. Look upstream.	#1136
137	4 Oct 81, Station 100+75, range 100' U/S. Filling joints in Middle Creek limestone with grout.	#1137
138	4 Oct 81, Station 100+70, range 200' U/S. Look upstream compacting fill against Middle Creek limestone.	#1140
139	19 Oct 81, Station 101+00. Look west at Bethany Falls limestone.	#1157
140	5 Nov 81, Station 101+70. Look D/S. Sand filter along top of Bethany Falls limestone.	#1193
141	27 Nov 81, Station 101+60. Look west at Bethany Falls limestone. Tarps cover Stark-Galesburg shale. Above, the Bethany Falls.	#1216
142	28 Nov 81, Station 102+00. Look D/S at top of Bethany Falls limestone.	#1217
143	29 Nov 81, Station 102+30. Look west at Stark-Galesburg Shale.	#1221
<u>STAGE II CONSTRUCTION</u>		
144	9 July 83, Camera at Station 98+00, range 216' U/S. Look northeast at closure area (94+60 to 95+10). Right abutment in background.	#157
145	9 July 83, Station 95+30. Look east. Cleanup of Pleasant zone D in closure area.	#158
146	15 July 83, Camera at Station 96+00+. Look northeast at closure area.	#160
147	15 July 83, Camera at Station 94+85+. Look D/S. Placing pervious blanket in closure area downstream plug.	#161
148	18 Aug 83, Station 88+50, range 320' D. Look U/S. Joints in Pleasanton zone A sandstone. Strike N 12° E, spacing 3'.	#179
149	13 Sep 83, Station 88+90+, range 200' D. Look U/S lean concrete placed against Sniabar limestone.	#187

TABLE OF CONTENTS--cont'd.

PHOTOGRAPHS--cont'd.

<u>PHOTO NO.</u>	<u>SUBJECT</u>	<u>NEGATIVE NO.</u>
<u>STAGE II CONSTRUCTION</u>		
150	13 Sep 83, Station 88+90+, range 200'+ D. Look D/S lean concrete placed against Sniabar limestone.	#188
151	6 Oct 83, Station 102+00. Look downstream at Winterset limestone.	#206
152	6 Oct 83, Station 102+00. Look downstream at Winterset limestone.	#207
153	7 Oct 83, Station 101+50, range 50'+ D. Look west at Winterset limestone downstream wall of cutoff trench.	#208
154	14 Nov 83, Station 102+10, range 50'+ D. Look west at Winterset limestone downstream wall of cutoff trench.	#222
155	14 Nov 83, Station 102+10, range 50'+ D. Look west at Winterset limestone downstream wall of cutoff trench.	#223
156	14 Nov 83, Station 102+10, range 50'+ D. Look west at Winterset limestone downstream wall of cutoff trench.	#224
157	14 Nov 83, Station 101+90 . Look west at Winterset limestone.	#225
158	14 Nov 83, Station 102+10 . Look west at Winterset limestone. Upstream wall of cutoff trench.	#226
159	14 Nov 83, Station 102+25 . Look west at Winterset limestone. Upstream wall of cutoff trench.	#227
160	14 Nov 83, Station 102+25 . Look west at Winterset limestone.	#229
161	9 July 84, Station 87+50. Look at upstream wall of cutoff trench. Stark-Galesburg shale.	#267
162	17 July 84, Station 85+95+. Look west at top of Winterset limestone.	#271
163	18 July 84, Station 87+50. Look downstream at Stark-Galesburg shale.	#272
164	31 July 84, Station 87+30. Look downstream at Winterset limestone.	#273
165	31 July 84, Station 87+30+, range 60'+ UP. Look downstream at Stark shale.	#275
166	6 Aug 84, Station 103+00. Look west at Block limestone.	#277
167	6 Aug 84, Station 103+00. Look west at Block limestone.	#278
168	16 Dec 82, Clay blanket area. Look east at Bethany Falls Slide Block	#13
169	16 Dec 82, Clay blanket area. Look E.S.E. at Bethany Falls Slide Block.	#23

OPERATION AND MAINTENANCE MANUAL
LONGVIEW LAKE
LITTLE BLUE RIVER, MISSOURI

APPENDIX IV
CONSTRUCTION FOUNDATION REPORT

CHAPTER 1

INTRODUCTION

1-01. Location and Description. The Longview damsite is located on Little Blue River at approximately 109th Street Kansas City, Missouri. The entire lake is located in Jackson County, Missouri. A location and vicinity map is shown on Plate No. 1 and a general plan of the damsite is shown on Plate No. 2. Drainage area above the dam is 50.3 square miles. The flood control pool, elevation 909 m.s.l. covers 1,960 acres and stores 24,800 acre-feet of water. The multipurpose pool, elevation 891 m.s.l. covers 930 acres and stores 22,100 acre-feet of water. The dam consists of:

a. A rolled earth embankment approximately 1,900 feet long and 110 feet above stream bed. Top of dam is elevation 926.6 m.s.l. Volume of the embankment is approximately 3,340,000 cubic yards.

b. An uncontrolled, limited service spillway near the left abutment; and

c. An outlet works located near the base of the left abutment. The outlet works consists of approach and outlet channels, a concrete intake tower, conduit and stilling basin. Twin 54 inch diameter, concrete sewer pipes are encased under the concrete conduit. The intake tower includes:

(1) An uncontrolled drop inlet for normal lake water releases;

(2) An emergency drawdown passageway to evacuate the lake;

(3) A low flow wet well with two intake ports for low flow releases; and

(4) A dry well for sewer gates and for access to inspect and maintain the sewer. A service bridge provides access to the intake tower for operation and maintenance.

1-02. Construction Authority. Longview Lake was authorized by the Flood Control Act of 1968 as a part of the, "Project for flood control and other purposes on the Little Blue River in the vicinity of Kansas City, Missouri, . . . substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 269, Ninetieth Congress . . ."

1-03. Purpose of Report. The purpose of this report is to provide a record of foundation conditions encountered during construction and methods used to adapt to these conditions. This information is a part of the permanent collection of project engineering data required by ER 1110-1-1801, change 2, dated 1 April 1983.

1-04. Contract and Supervision. The Stage I contract (DACW41-79-0114) was awarded to W.A. Ellis Construction Co., Kansas City, Missouri, 24 August 1979, for a low bid of \$11,865,103.00. The following items of work were involved:

- a. Clearing and Grubbing
- b. Excavate:
 - (1) Cutoff trenches on both abutments
 - (2) Outlet works and outlet channel
 - (3) Both abutment foundations to firm bedrock
 - (4) Diversion channel
- c. Construct diversion dike and protective plugs and protective dike along right side of outlet works on downstream side of dam axis to elevation 823.
- d. Relocate existing sewers and utilities and construct concrete outlet works tower, conduit and stilling basin.
- e. Construct embankment on right side, station 89+50+ to station 93+40+ to elevation 869 and on left side, station 95+50+ to station 100+50+ to elevation 867.
- f. Construct downstream bridge over outlet channel.
- g. Perform curtain grouting along dam axis.

Stage I construction work began 12 September 1979 and was completed 16 October 1982. C. E. Ponder Construction Co. was subcontractor for the concrete portion of the outlet works. The grouting subcontractor was Boyles Brothers Drilling Co., Salt Lake City, Utah. Grouting began 14 April 1980, and was completed 6 February 1981. The Resident Engineers for Stage I construction were Mr. Orval Jensen, May 1979 to May 1980 and Mr. Joseph L. Lilley, May 1980 to October 1982. The contractor's Project Manager was Mr. John A. Strosnider. Project Geologists were Mr. William F. McFarland, 1 September 1979 to 15 November 1979, and Mr. William F. Lowe, 15 November 1979 to October 1982.

The Stage II contract (DACW41-82-C-0204) was also awarded to W. A. Ellis Construction Company of Kansas City, Missouri, 7 July 1982, for a low bid of \$9,181,143.00. The following items of work were involved:

- (1) Excavate spillway
- (2) Complete embankment
- (3) Complete installation of electrical and hydraulic equipment in intake tower
- (4) Construct service bridge

(5) Construct access roads and service roads

Stage II construction work began 25 August 1982, and was completed 12 September 85. The Resident Engineer was Mr. Joseph L. Lilley. The contractor's Project Managers were Mr. W. A. Ellis and Mr. Harry A. Wallace. The Project Geologist was Mr. William F. Lowe.

1-05. Quality Control. The contractor's quality control staff for Stage I construction consisted of: Mr. J. A. Strosnider, chief; Mr. Leo Vasco and two to three laboratory men who also did survey work. For Stage II construction the chiefs were Mr. W. A. Ellis and Mr. H. A. Wallace. The two or three laboratory technicians again performed the survey work. The contractor's quality control program did not perform satisfactorily because they were in the employ of the contractor. The Government's quality assurance, (inspectors), were the significant quality control agent on this project.

CHAPTER 2

FOUNDATION EXPLORATIONS

2-01. Investigations Prior to Construction consisted of field reconnaissance, study of aerial photos, review of published literature, a geophysical survey, drilling, pressure testing of bedrock and sampling and testing of overburden and bedrock. A total of 350 borings and test pits were completed by government drill crews prior to Stage I construction. Thirty-three bedrock borings were pressure tested. A summary of drilling follows:

BORINGS DRILLED PRIOR TO CONSTRUCTION (11 Mar 66 to 12 Sep 79)

<u>Type</u>	<u>Number of holes</u>	<u>Total lineal feet drilled</u>	<u>Lineal feet Bedrock core only</u>
Core holes			
6-inch	5	138.1	138.1
4-inch	1	70.3	70.3
2 1/8-inch (NX)			
(includes 76 angle holes)	14	454.4	454.4
1 7/8-inch (NQ)	7	754.3	754.3
Drive holes	123	1,765.1	
Drive and 6-inch core	2	439.5	410.0
Drive and 4-inch core			
Drive and 2 1/8-inch core	3	352.2	294.6
Drive and 1 7/8-inch core	4	605.3	538.8
Undisturbed push	19	248.3	
Undisturbed and 6-inch core	4	107.7	43.7
Undisturbed and 4-inch core	4	254.7	178.1
Undisturbed and 2 1/8-inch core	5	228.2	154.5
Auger	99	1,252.1	
Auger and 6-inch core	6	405.5	285.5
Auger and 4-inch core	1	102.4	78.0
Auger and 2 1/8-inch core	42	1,590.2	861.0
Test Pits	11		
TOTALS	350	8,758.0	4,251.0

Drive holes were made with 6-inch, 4-inch and 2-inch diameter drive barrels. Undisturbed soil samples were taken with 5-inch and 3-inch diameter shelly tubes. Eleven NX, angled, core holes were drilled on the left abutment and five were drilled on the right abutment. Thirty-three bedrock borings were pressure tested with water.

2-02. Investigations During Construction. During construction Government drill crews completed 252 borings and test pits. A summary of drilling follows:

BORINGS DRILLED DURING CONSTRUCTION (12 Sep 79 to 16 Sep 82)

<u>Type</u>	<u>Number of holes</u>	<u>Total lineal feet drilled</u>	<u>Lineal feet Bedrock core only</u>
Core holes			
6-inch			
4-inch	5	481.0	481.0
2 1/8-inch	2	29.0	29.0
1 7/8-inch			
Drive holes	179	2,668.6	
Drive and 6-inch core			
Drive and 4-inch core	1	31.9	16.5
Drive and 2 1/8-inch core			
Drive and 1 7/8-inch core			
Undisturbed Push	48	1,486.4	
Undisturbed and 6-inch core			
Undisturbed and 4-inch core	3	107.9	61.9
Undisturbed and 2 1/8-inch core			
Auger	12	104.1	
Auger and 6-inch core			
Auger and 4-inch core			
Auger and 2 1/8-inch core			
Test Pits	<u>2</u>	<u> </u>	<u> </u>
TOTALS	252	4,908.9	588.4

CHAPTER 3

GEOLOGY

3-01. Regional Geology and Physiography. Longview Lake is located in the extreme northern part of the Osage Plains Section of the Central Lowlands Physiographic Province. The Osage Plains Section is characterized by old scarp plains beveling faintly inclined strata. The Dissected Till Province which borders immediately to the north of the project is characterized by submaturely to maturely dissected till plains. A maturely dissected drainage pattern developed during pleistocene time trends north into Missouri River. The project is located on the southern boundary of the Kansan Age Glacial Stage. Scattered till deposits of loess up to 7 feet thick are present on the uplands in the area. These deposits thicken to up to 90 feet along the Missouri River bluffs.

3-02. Site Geology. Gently rolling uplands surround Longview Lake. The Little Blue River flows generally north in a meandering, incised channel cut through alternating limestone and shale strata. At the damsite the valley is about 1,800 feet wide from bluff top to bluff top and topographic relief is about 120 feet. The Bethany Falls limestone member of the Kansas City Group, Missourian Series, Pennsylvanian System is a prominent scarp forming ledge in the reservoir area. Its thickness is about 18 feet and it dips gently from elevation 885 on the right abutment to elevation 876 on the left abutment. Bedrock on the lower valley walls and valley floor is made up of less resistant shale and siltstone of the Pleasanton Group. See Plate No. 31.

3-03. Description of Overburden. Overburden on the uplands in the general area consists of up to 30 feet of residual clay and scattered deposits of wind blown loess up to 20 feet thick. No loess deposits were encountered at the damsite. Overburden on the valley side slopes consists of residual clays and colluvium with clayey gravel at the base of the slopes. Alluvium in the valley consists of 12 to 29 feet of predominately lean clay with lesser amounts of fat clay and silty, sandy gravel, in the basal 7 feet, resting on shale and siltstone bedrock.

3-04. Bedrock Stratigraphy. Bedrock at the damsite consists of alternating beds of limestone and shale of the Kansas City Group overlying a more massive section of less resistant clayey and silty shale, siltstone and sandstone beds of the Pleasanton Group. These rocks are classified as lower Pennsylvania Series. See Plate No. 26. Underlying the Pennsylvanian rocks are about 2,200 feet of older sedimentary strata. Only the lower one-half of the Kansas City Group and the upper one-third of the Pleasanton group are exposed at the damsite. See General Geologic Column and Legend on Plate No. 26. Bedrock units exposed at the damsite are described in descending order in the following paragraphs.

KANSAS CITY GROUP

Cherryville Formation

Westerville limestone member is moderately hard, finely crystalline, medium to thick bedded, fossiliferous, light gray limestone. The upper part is sometimes pitted, cross-bedded and oolitic. Thickness is 9 feet.

Wea shale member is about 11.5 feet thick on the right abutment. The upper one-third is soft, blocky, clayey to silty, calcareous, dark gray shale. The lower two-thirds is moderately hard, dense to finely crystalline, thin to medium bedded, fossiliferous, blue-gray limestone with occasional dark gray shale bands and beds. Wea shale on left abutment is soft interbedded shale and limestones laminated to thin bedded, highly weathered and tan. The thickness on this abutment is approximately 7 feet.

Block limestone member is moderately hard, finely crystalline, medium to thick bedded, fossiliferous, argillaceous, medium, gray with one or more thin beds of dark gray shale. Thickness is 3.5 feet.

Fontana shale member is soft, platy to blocky, silty, calcareous, dark gray, with limestone nodules common in lower part. Thickness is 3 feet.

Dennis Formation

Winterset limestone member is moderately hard, finely crystalline, thin to medium bedded, argillaceous, pitted and light gray with wavy shale partings and occasional thin beds of dark gray shale. Thickness is 13.5 feet.

Stark shale member is soft, fissile to blocky, carbonaceous, dark gray to black. Thickness is 3 feet.

Galesburg Formation

Galesburg shale member soft, clayey, calcareous, medium to dark gray with numerous multidirectional slickensides in fractures and occasional small coal pockets. The thickness is approximately 4 feet.

Swope Formation

Bethany Falls limestone member. Upper part is moderately hard, dense to finely crystalline thin to thick bedded, stylolitic, nodular and mottled light and dark gray. The lower part is moderately hard, fine grained to lithographic and light gray with numerous thin shale partings. Thickness is 185 feet.

Hushpuckney shale member. The upper part is soft, clayey, platy, calcareous and medium gray. The lower part is soft, fissile, carbonaceous, calcareous with occasional siltstone partings and pyrite nodules, dark gray to black. Thickness is 6.5 feet.

Middle Creek limestone member consists of two limestone beds separated by a 0.4-foot shale bed. The limestones are moderately hard, dense to finely crystalline light to medium gray. Thickness is 1.5 feet.

Ladore Formation

Ladore shale member soft, thin to medium bedded, blocky, calcareous with occasional multidirectional slickensides on fractures. It is blue gray. Thickness is 3.5 feet.

Hertha Formation

Sniabar limestone member is moderately hard, dense to finely crystalline, thick bedded, mottled light and darker gray and contains 2 thin shale beds. Thickness is 6 feet.

Mound City shale member is soft, platy, clayey to silty, brownish-gray to dark gray. Thickness is 3.5 feet.

Critzer limestone member: The upper part is soft, silty calcareous, blocky, light to medium green-gray shale with limestone nodules. The lower part, when present is moderately hard, argillaceous, sandy, thin to medium bedded, light gray limestone. Thickness is 2.5 feet. The upper shale portion is absent on the right abutment.

PLEASANTON GROUP

Pleasanton Formation

Zone A is sandstone, moderately hard, very fine grained, thick bedded to massive, argillaceous, calcareous, green-gray. Thickness 6 feet.

Zone B is shale, soft, platy, silty, dark gray. Upper part is interlaminated with medium gray siltstone partings and is occasionally calcareous and slightly micaceous. Thickness is 20 feet.

Zone C is limestone, argillaceous, moderately hard, very fine grained to dense, thick bedded to massive, medium to dark gray and fossiliferous, thickness is 6 feet.

Zone D is calcareous siltstone, moderately hard, thick bedded to massive occasionally shaly, medium to dark gray.

Zone E is argillaceous siltstone, soft to moderately hard, medium bedded to massive, medium to dark gray with, occasional interlaminated light and dark gray sandstone partings.

3-05. Bedrock structure, jointing. Longview Reservoir is located on the southeastern flank of the Forest City Basin, a synclinal structure about 260 miles long, north, northeast, by 140 miles wide, east, southeast. The regional dip of bedrock ranges from 10 to 20 feet per mile west, northwest, but local variations in dip and strike occur. At the damsite bedrock dips 1 foot in 300 feet to the east into the right abutment and 1 foot in 65 feet to the west into the left abutment.

Jointing of beds may be very intense locally, due to dome-related flexures. Primary joints are generally vertical and strike North 50° East spaced 5 to 35 feet apart. Joints, especially in the Bethany Fall limestone are solution weathered and widened up to 5 feet wide near outcrops.

Secondary joints are generally, vertical, tight, strike North 75° West and spaced about 2 feet apart. During recent investigations by Dr. Richard J. Gentile, University of Missouri-Kansas City, fault complexes, associated with small anticlines and synclines were found in southern Jackson

County. A draft copy of his report "Faulting of the Bethany Falls limestone and associated strata at Kansas City, Missouri - A Preliminary Report," was furnished Kansas City District by the author. The report is based upon studies of a series of faults exposed along a one mile reach of newly excavated road cut for highway I-470, located about 3/4 mile north of the damsite. Faulting could not be traced into the soil profile. The report study is a rectangular-shaped, downdropped block encompassing an area three miles long and two miles wide. The southern limit of the report area includes Longview damsite. The downdropped block, named by the author, "Ruskin Heights fault complex," is divided into several small blocks by a series of normal faults trending northwest-southeast with displacements of a few inches to over 10 feet. Dr. Gentile had projected two fault traces through the dam axis but no evidence of faulting was found in the cutoff trenches or foundation excavations during construction.

For site specific joint patterns, see the foundation maps on plate Nos. 72 thru 85.

3-06. Bedrock Weathering. Depth and degree of weathering vary considerably with rock type and thickness of soil cover. The limestones are softened and stained to depths of a few inches to 5 feet below their surface. Vertical joints in the Bethany Falls limestone are often 2 to 5 feet wide and extend the full thickness of the ledge near the outcrop. The Bethany Falls crops out prominently along the valley wall and partially filled joints, up to 5 feet in width, are apparent at the outcrop. These joints commonly occur in two nearly vertical sets with general strikes of ENE (nearly parallel to the dam axis) and NNW (approximately perpendicular to the dam axis) and tighten into the abutments. By 50 feet into the abutment the effects of weathering of the Bethany Falls appears to have been moderated by the presence of overlying shale. Large blocks of Bethany Falls measuring up to 15 feet or so in their greatest dimension have become detached at the joints due to the weathering and erosion processes with some blocks moving down slope. Neither the Winterset nor the Sniabar limestone form prominent outcrops in the abutments and are commonly mantled by a 1 foot to 8 foot depth of overburden. Weathering effects extend as much as 12 feet beneath the bedrock surface of the interbedded limestones and shales.

3-07. Solution Activity. Extensive solutioning and cavern development, often found in thick, massive limestone strata in southern Missouri is not present at the damsite. Significant solution activity has enlarged joints in the Sniabar, Middle Creek, Winterset, Bethany Falls and Winterset limestones. Several open joints in the Sniabar on the right abutment contain travertine coatings and a large overhanging face on the Bethany Falls (in the clay blanket area) had numerous stalagmites formed in an enlarged bedding plane. The overhang and enlarged bedding planes were removed by blasting. Three openings into large solution cavities were encountered on top of the Bethany Falls limestone. Two of these were on the left abutment and were removed by moving the rock excavation further upstation, (into the abutment). The third was on the right abutment and was gravity grouted with 1:1 cement grout. During preparation of the Bethany Falls under the clay blanket, a solution enlarged open joint partially filled with grout was encountered. This joint is apparently connected to the grouted solution cavity approximately 500 feet away. This joint was also treated with concrete and additional grout under the clay blanket.

3-08. Ground Water. Ground water occurs under three conditions:

- a. Water-bearing alluvial sand and gravel.
- b. Bedrock fractures usually in shallower limestone and shale; and
- c. Porous sandstones usually of the Pleasanton and underlying Cherokee groups.

Yields from alluvial wells may vary considerably, with the exception of those from Missouri River and lower Blue River alluviums. Due to extensive urban development and the presence of numerous sewage lagoons, septic tanks, and cesspools, water from the Blue River alluvium and from the bedrock fracture zones may be highly polluted. Deep wells in the Pleasanton and lower sediments have varying yields, are usually very mineralized, and occasionally have artesian heads.

3-09. Engineering Characteristics of Overburden Materials. Overburden materials excavated from the cutoff trench and outlet works were predominately lean and fat alluvial clays suitable for use in the impervious fill zones. Overburden removed from the abutments was predominately lean and fat residual clays suitable for random and berm zones. Specifications for the stage I Contract required that impervious fill material have a liquid limit ≤ 55 and be compacted in 8-inch lifts with 6 passes of a tamping roller. Random fill was placed in either 8-inch lifts, using 6 passes of a tamping roller, or 12 inch lifts using 3 passes of a 50-ton rubber tired roller. Most of the berm was placed in 24-inch lifts and compacted with the rubber tired roller.

3-10 Engineering characteristics of Bedrock Materials. Shales and sandstone excavated in the cutoff trench, outlet works and abutments were used in the berm zones. Limestones excavated in the abutments were used for added stability and protection on the upstream clay blanket.

3-11. Unusual or Unanticipated Geologic Conditions Encountered During Construction.

a. Major earthslide. A major earth slide, (3900+ cy), occurred on 18 November 1979, on the left side slope of the outlet works excavation between O. W. station 55+00+ and station 57+50+. See photo 26, taken on 5 March 1980. The slide plane was at the contact of overburden and bedrock, (Pleasanton zone B shale), and vertical displacement totalled about 5 feet. Several small overlapping scarps 3 to 4 feet high were formed in the slide area. The slide material was excavated exposing unweathered shale and backfilled with required overburden excavated downstream on the left abutment. See photo 49 which shows the reworked slide area on 17 February 1981. Because of the occurrence of this slide and the generally unstable condition of the talus slope further downstream, the proposed new sanitary sewer was relocated to the right side of the outlet works. See plate No. 9 which shows the final alinement and plate No. 15 which shows the original alinement of the sanitary sewer.

b. Minor earth slide. On 23 March 1980 a series of three small slides totaling about 160+ cy occurred on the left side slope of the outlet works excavation between O. W. station 50+00+ and station 52+00+. See photo 27. This slide plane was also at the overburden - shale contact. On 1 December 1980, a second slide occurred in this area. See photo 48. Note the dark blue, soft, Pleasanton, zone B shale exposed along the slide scarp. As a result of these overburden slides, the contract was modified to remove all overburden on the left abutment, downstream of the cutoff.

c. Rock slide. On December 16, 1982, a large wedge-shaped block of Bethany Falls limestone separated from the outcrop face and moved several feet down slope. The block contained approximately 200 cubic yards. There was no apparent slide of any foundation material below the block, it simply separated from the outcrop at the intersection of two vertical joints and slid on the underlying shale slope. The location of this block was approximately 400 feet upstream of the dam centerline. The joint surfaces exposed showed signs of significant solution activity in the form of travertine and flowstone deposits. See photos #168 and 169.

CHAPTER 4

SPECIAL DESIGN CONSIDERATIONS

4-01. Design Consideration. One unique feature of Longview dam is the twin 54-inch diameter sewer pipes incorporated in the concrete conduit and the sewer gates and gate well built into the intake tower. Sewage flow was maintained during construction of the embankment and outlet works.

Also unique at Longview was the presence of numerous open and clay-filled joints in the bedrock units of both abutments. Extensive rock excavation was required to expose sound bedrock surfaces and affect a water tight seal between bedrock and embankment materials. A considerable amount of dental concrete was required. See paragraph 7-01 c.

CHAPTER 5

EXCAVATION PROCEDURES FOR COMPONENT PARTS

5-01. Excavation Grades. Overburden side slopes in the cutoff trench were excavated 1V on 2H and bedrock slopes were excavated 1V on 1H. Overburden side slopes in the outlet works were excavated 1V on 2.5H. Outlet channel slopes were cut 1V on 3H. Side slopes for the sewer relocation were cut 1V on 2H. Bedrock slopes in the abutment foundations were sloped 1V on 1H, and 1V on .5H.

5-02. Dewatering Provisions. All excavation and fill placement were performed in the dry. Very little seepage water entered the excavations. Rainwater seepage and wash water was collected in sumps and pumped out with small gasoline driven pumps. One large sump was used downstream of the stilling basin excavation and a large sump was located in the closure area of the cutoff trench near station 96+50.

5-03. Overburden Excavation. Overburden excavated in the cutoff trench, outlet works and abutment foundations included: silt, sand, clay and weathered shale. These materials were excavated with dozers, scrapers, front end loaders and a backhoe. Wet areas were excavated with a dragline. Overburden excavation for the outlet works totalled 129,143 cy; for the cutoff trench 46,057 cy; for the abutment foundations 45,872 cy.

5-04. Rock Excavation. The uppermost bedrock unit in the excavations was the Wea shale, BOT El 917 in the right abutment cutoff trench from station 86+00 to station 86+34. The lowest bedrock unit excavated in the cutoff trench was the upper 2 to 3 feet of Pleasanton zone D, a calcareous siltstone. Zone D forms the floor of the cutoff trench from station 89+74, elevation 803.5, to station 98+55, elevation 804.4. Limestone and sandstone bedrock units in the cutoff were excavated by presplit drilling and blasting. The shale and siltstone units were excavated with a backhoe and dozer. Bedrock units excavated in the outlet works ranged from the upper 2 feet of Pleasanton zone C, elevation 803.0, an argillaceous limestone at the intake tower, to the upper 12 feet of Pleasanton zone D, elevation 791, an argillaceous siltstone at the stilling basin. Rock excavation in the cutoff trench totaled approximately 3,938 cubic yards; in the outlet works, 53 cubic yards, and in the abutment foundations 31,799 cubic yards.

5-05. Line Drilling and Presplitting.

a. Line drilling was not employed but presplitting was required for all slopes 1V on 1H or steeper in limestone foundations and side slopes in the cutoff trench and for "special surfaces" in the outlet works excavations. Presplit drilling and blasting, (shot #1) began with the Bethany Falls limestone about 200 feet upstream on the left abutment on 26 December 1979. Presplit holes were 2 3/4-inch diameter and excavation blast holes were 2 3/4-inch and 3-inch diameter. Presplit holes were drilled on 28-inch centers, loaded with Detagel (.25 lbs/ft.) and 60-grain primacord and stemmed 2 1/2 feet. Results were good. The same spacing and loading were used with the Winterset limestone with generally acceptable results. Presplit drilling and blasting of Snihbar limestone began on the right abutment upstream on 20 May 1980, (shots #44-#47). Presplit holes were spaced on 24-inch centers,

loaded with Detagel (.25 lbs/ft.), and stemmed 3 feet. The ledge had numerous open vertical joints which crossed the presplit line. Results were poor and the resulting rock faces required an excessive amount of repair including sealing with concrete, prior to fill placement.

b. Sniabar limestone presplit test shots. The contract was modified to add two additional presplit test shots in Sniabar limestone. The first Sniabar presplit test (shot #53) was located on the left abutment at the upstream toe. Twenty-five feet of the presplit line were drilled with 24-inch hole spacing and the other one-half of the line was drilled with 12-inch spacing. All holes were sloped 1V on .5H and loaded with 2 strands of 200-grain primacord and stemmed full depth. Good fracture between holes was achieved. Production blast holes (shot #54), were drilled on a 5- by 7-foot pattern and loaded with one 2- by 8-inch Detagel primer, N-C-N 100 prills and stemmed 3 feet. The first row of production blast holes was drilled 2-1/2 feet deep and spaced 4 feet ahead of the presplit line. These holes were loaded with one 2- by 5-inch Detagel primer and stemmed full length. Fragmentation was good but Sniabar limestone in this area was of higher quality than had been encountered up to that date.

The second test shot #55 was located near the downstream toe trace of Sniabar limestone on the left abutment. Sniabar limestone on the downstream side of the dam had more vertical joints than on the upstream side. The presplit line was positioned between and roughly parallel to two open joints. The landward joint was 2 inches wide and from 2 to 4 feet from the presplit line. The riverward joint was about 8 feet from the presplit line. One-half the holes were on 24-inch centers and one-half were on 18-inch centers. All holes were sloped 1V on .5H and loaded with a single strand of 200-grain primacord. Production blast holes, (shot #56), were drilled and loaded as in the upstream test section. The resulting presplit face was good. There was no backbreak into the landward open joint and the presplit line cut through the riverward joint. All remaining presplitting on both contracts was performed using 1 or 2 strands of 200-grain primacord and 30-inch hole spacings. In a very few cases, the presplit crack did not develop with the first firing. When this occurred, the blast blew all the stemming out of the holes and they were reloaded with an extra strand of primacord and reshot. Presplit results for all formations, using this method, were excellent. For a summary of all blasting performed, see tables on plate Nos. 107 and 108 in VOLUME TWO of this report.

c. Non-Explosive Demolition Agent. A portion of the Sniabar limestone on the left abutment from 15 to 50 feet upstream was not presplit prior to curtain grouting. Since the contract precluded any blasting within 50 feet of the grout curtain, a non-explosive demolition agent was used. The brand name of the product is Bristar. It was poured into previously drilled "presplit" holes and allowed to expand for approximately 5 days. A fracture between holes was created and the detached rock removed leaving an acceptable face.

5-06. Foundation preparation.

4. Cut-off trench. A cut-off trench was excavated to be back from station 86+00 on the right abutment to station 104+00 on the left abutment. Overburden thickness ranged from 0 feet on the abutments to up to 20 feet in the valley. Side slopes in the overburden were cut 1:1 on 2H and bedrock

slopes in limestones were presplit 1V on 1H. The floor of the trench was 30 feet wide. Beginning on the right abutment the floor of the trench descends from elevation 926, (top of Wea shale at station 84+00) to elevation 803.5, (Pleasanton Formation zone D siltstone at station 89+73) via a series of horizontal benches and 1V on 1H slopes. From station 89+73 to station 98+95 the floor of the trench is on Pleasanton Formation zone D siltstone, (elevation 803.5 to elevation 804.8). At station 98+95 the floor of the trench ascends the left abutment via a series of benches and 1V on 1H slopes. Bedrock slopes were excavated with backhoes and presplit blasting to minimize damage to the surfaces. After completion of curtain grouting the final bedrock surface was cleaned with air-water jets and backfilled with 12 inches of compacted impervious clay. See photos: 65, 88, 96, 98, 99, 102, 104, 110, 134, 136 and 138. Subcrops of the limestone on both abutments were "trimmed back" to firm rock, not only in the cutoff trench but for distances of up to 400 feet downstream and 235 feet upstream. In several areas, dry pack, slush grout or concrete bulkheads were placed against the limestone faces in order to seal off weathered vertical joints and bedding planes. See photos: 75, 132, 149, 150, 154, 155, 156, 157, 158 and 164.

b. Outlet works. Overburden excavation averaged about 30 feet wide and 10 feet deep and side slopes were cut 1V on 2.5H. Rock excavation was from 2 to 4 feet deep and was accomplished with a backhoe, jack hammers and dozers, except in the intake tower area where a rock saw was used to make vertical cuts. Bedrock units excavated ranged from the upper 2 feet of Pleasanton zone C, an argillaceous limestone, down to the upper 12 feet of Pleasanton zone E, an argillaceous siltstone. See photos 35, 36 and 37. The final foundation surface was excavated with a "roto mill," a large track-mounted cutting roller. See photos 10 and 11. Small areas of weathered joints were "cleaned out" with air spades.

Air-water jets were used to clean the final bedrock surface just prior to placing a 6-inch layer of lean concrete. See photos: 13, 17, 19, 21, 22, 23 and 31.

CHAPTER 6

FOUNDATION ANCHORS AND ROCK BOLTS

6-01. Foundation anchors and rock bolts were not used on this project.

CHAPTER 7

CHARACTER OF FOUNDATION

7-01. Foundation Surface.

a. Valley section. All of the embankment foundation was stripped of boulders, sod, roots, tree stumps, etc., disked a minimum depth of 8 inches and compacted with a minimum of three passes of a rubber-tired roller. The existing 48-inch diameter RCP sewer pipe, which crossed the dam axis at station 97+95 was removed. The floor of the pipe excavation, (Pleasanton zone B shale), was cleaned with air-water jets. The vertical side slopes, (Pleasanton zone A sandstone), were, "trimmed back" to remove overhanging ledges. The pipe excavation was backfilled with compacted impervious clay. See photo 54.

b. Outlet works. The uppermost bedrock unit excavated in the outlet works was Pleasanton zone C, an argillaceous limestone, which is the foundation of the intake tower from station 45+32+ to station 46+02+. The limestone was moderately hard, massive and dark gray. Blasting, backhoes and airspades were used to excavate the material (see shot report #26.) A rock saw was used to excavate the vertical cut along the sides. See plate No. 72 and photos 35 and 36. Pleasanton zone C extends to station 46+02+. From station 46+02+ to station 50+80+ the foundation surface is Pleasanton zone D, a moderately hard, massive gray calcareous siltstone and interbedded shale. See plate Nos. 73 and 74 and photos 28, 30, 31 and 32. From station 50+80+ to the end of the stilling basin, station 55+44, Pleasanton zone E is the foundation surface. Zone E is a soft to moderately hard argillaceous siltstone, medium bedded to massive and dark gray. See plate Nos. 74 and 75 and photos 18, 19, 21, 22 and 37. The final foundation surface in the outlet works, except for the intake tower area and the stilling basin area, was excavated with a "roto mill," a large track-mounted cutting roller. See photos 10 and 11.

c. Abutment foundations. In order to effect a tight seal between bedrock and impervious fill it was necessary to "trim back" the subcrop faces of the several limestone ledges on both abutments. The faces were presplit blasted on a slope of 1V on 1H and 1 on 1.5 for several hundred feet upstream and downstream of the dam axis. In some areas concrete bulkheads were placed against the bedrock faces to seal open bedding planes and vertical joints, and achieve desired slope. In other areas the open joints on top of horizontal benches were gravity grouted. See photos 23, 24 and 25. A total of 279.75 sacks of cement were used to dry pack joints or is poured grout at 35 separate locations. A total of 342.7 cubic yards of lean concrete was placed behind forms to seal joints and maintain 1V on 1H or 1V on 1.5H slopes at 19 separate locations. See photos 132, 133, 134, 135, 136 and 137.

d. Cutoff trench. See paragraph 5-25.

7-02. Condition of Foundation Soil or Rock. The foundation under the main embankment consists of 12 to 29 feet of predominately lean clay with lesser amounts of fat clay. One to seven feet of silty, clayey gravel rests on the bedrock. The cutoff trench cuts through this material to bedrock across the entire valley from right to left abutment. See map plate Nos. 76 through 85.

7-03. Ground Water. All excavations were performed "in the dry." Gasoline pumps were used to dewater excavation areas. Small seeps (less than 1/2 gallon per minute) were encountered in several areas in the outlet works excavation. These areas were blown with air just prior to placing lean concrete. In the cutoff trench a considerable quantity of ground water entered the excavation; an estimated 30 to 50 gallons per minute, from station 90+10+ to station 91+10+ on the upstream side. The water was coming from a clayey gravel layer about 4 feet thick resting on bedrock. See photos 65, 66 and 67. Five gallon metal cans, with bottoms removed, were placed on bedrock at several locations to act as collectors. Water which entered the cans was pumped out with small gasoline powered pumps. As more layers of compacted fill were placed, additional cans, with tops and bottoms removed, were added to the initial cans. After three layers of cans had been installed (4.5 feet of head +) the ground water inflow stopped. The cans were filled with sand and impervious fill placement was continued.

CHAPTER 8

FOUNDATION TREATMENT

8-01. Curtain Grouting. The grout curtain consists of three lines of grout holes in the abutments and a single line of grout holes in the valley. All of the grout holes were inclined landward 30 degrees from vertical, and drilled parallel to dam centerline into the abutment.

Line A is 10 feet downstream and line B is 10 feet upstream of line C which is on the dam axis. See plates Nos. 43, 44 and 45. Grouting was performed from the floor of the cutoff trench on bedrock through 2 3/4-inch diameter steel pipes (nipples), 2 to 4 feet long, cemented 2 feet+ into bedrock. Grout holes were drilled with a Chicago Pneumatic, CP-65 rotary drill and 2 1/2-inch diameter, non-coring bits. Grout was mixed in a double-chamber mixer and agitator sump with a capacity of 20 cubic feet. Grout was pumped with a Moyno pump. Grout mixes ranged from 6:1 to 0.7:1, water cement ratio. Approximately 90 percent of the grout injected was 6:1. The stop grouting method was used. Grout holes were drilled to the total depth, washed through the drill rods, pressure tested and grouted through a packer which was set at successively shallower depths and lower pressures. The amount of water pressure and grout pressure applied was only that amount required to balance the rock pressure at the packer depth. Water and grout pressure, packer depth and number of sacks of cement injected are shown on the grout curtain profiles (see plate Nos. 46 through 70). A summary of grout takes for each bedrock unit is shown on Plate No. 71. On the left abutment 42 percent of the grout was injected into the Bethany Falls limestone, 20 percent into the Sniabar limestone and 7.5 percent was injected into the Fontana shale. On the right abutment the largest takes were: Bethany Falls limestone, 30 percent, Fontana shale, 10 percent and Stark-Galesburg shale 9 percent. In the valley section, line C, all of the grout was injected into the Pleasanton zone D siltstone.

Drilling and grouting began 23 April 1980 in the valley section on line C at station 98+86 and proceeded downstation toward the right abutment. Line C grouting, on the right abutment, was completed at station 84+00 2 November 1980. Line C grouting on the left abutment began 29 September 1980, at station 98+86 and ended 7 February 1981 at station 112+C0. Drilling and grouting of lines A and B on the right abutment began 11 June 1980 at station 89+65 and ended on 28 August 1980, at station 86+35, line A and station 89+65, line B. Drilling and grouting of lines A and B on the left abutment began at station 100+05 on 9 September 1980, line A and 30 September 1980, line B and ended at station 103+85 on 20 November 1980, line A and 25 November 1980, line B. Grouting under the conduit was completed on 14 November 1980. No grout was injected see plate No. 18.

8-02. Drainage Provisions. Foundation drainage is provided by a 6-foot wide sand drain placed on the downstream side of the impervious core. The drain extends from top of bedrock to elevation 911.3 across the valley from right to left abutment. It connects with a 3-foot thick horizontal drain which covers all of the embankment foundation and exists at the downstream toe of the embankment. The top and sides of the outlet works conduit, downstream of the impervious core, are covered with a 3-foot thick layer of sand which also connects with the horizontal drain. The concrete inverted siphon which

passes under the new sewer line, and exits into the stilling basin was filled with coarse sand and capped at both ends with filter cloth. See photos 56, 57, and 58.

8-03. Foundation Compaction or Consolidation. This item is covered in paragraphs 5-06(a) and (b).

8-04. Dental Concrete and Gravity Grouting. This item is covered in paragraph 7-01(c).

8-05. Instrumentation. Six types of observation devices were installed in the embankment and foundation during construction. Of 10 piezometers, the tips of three are in foundation gravel, six are in foundation clay, and one is in foundation shale. Of 26 pore pressure devices, tips of seven are in foundation clay, eleven are in foundation shale, seven are in the embankment and one is in the horizontal drain. Of three foundation settlement devices the base plates of two are in foundation clay and the third is at the foundation contact between embankment fill and overburden foundation. Eight alignment monuments are located on line A, 200 feet downstream and nine are located on line B, 170 feet upstream. Seven crest settlements are located along the downstream crest of the dam at range 36' downstream. One tiltmeter was installed at range 2+75 D and 30 feet right of outlet works centerline. For locations and details see plate Nos. 104 and 105.

CHAPTER 9

POSSIBLE FUTURE PROBLEMS

9-01. Conditions That Could Produce Problems. There are no known foundations conditions under the embankment that might produce problems. Some seepage through the right abutment might be anticipated because excavation to "tight" bedrock was not feasible. However the extensive dental treatment to joints and the downstream drainage blanket should be adequate to limit and control any such seepage. Within the reservoir, areas where colluvium blankets Pleasanton zone B shale and is subject to under cutting by shoreline erosion, shallow overburden slides can be expected.

CHAPTER 10

OIL WELL PLUGGING

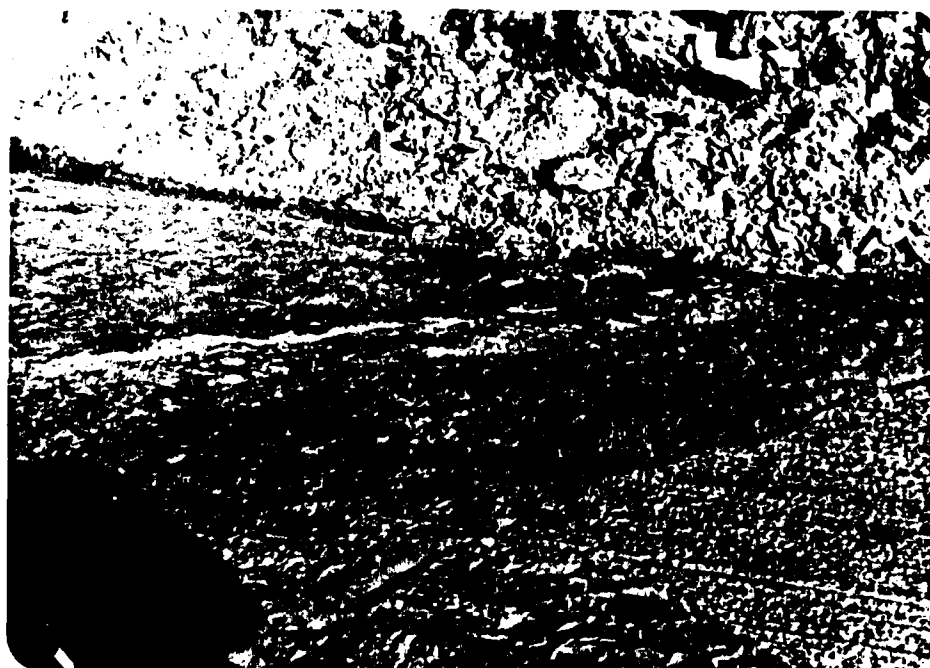
10-01. Oil Well Plugging. Near the southern limit of the Mouse Creek Branch of the lake there was a producing stripper oil field. The field consisted of 3 leases containing a total of 58 injection wells, 88 production wells and 1 water supply well. Town Oil Company of Paola, Kansas was the lease holder and was producing from the field. As part of the Government's acquisition contract, Town Oil was obligated to plug the wells. Town Oil contracted with Consolidated Oil Well Services, Chanute, Kansas to accomplish the work. Eleven wells, which would have interfered with the Scherer Road Relocation, were plugged in July 1982 and the remaining wells were plugged in May through July of 1983. The plugging consisted of pressure grouting the well from 20 feet above the producing formation to the bottom of the hole. After the grout had set up, the seal was tested using 400 psi to 700 psi pressure. Well casing was then shot using 1 pound explosive charges placed 50 feet (minimum) above the seal. The pipe was salvaged and the remaining hole was fill with tremied grout. The well plugging appeared effective, however there is a chance that some very old wells may exist for which there are no records, and therefore may not have adequate plugs.

PHOTOGRAPHS

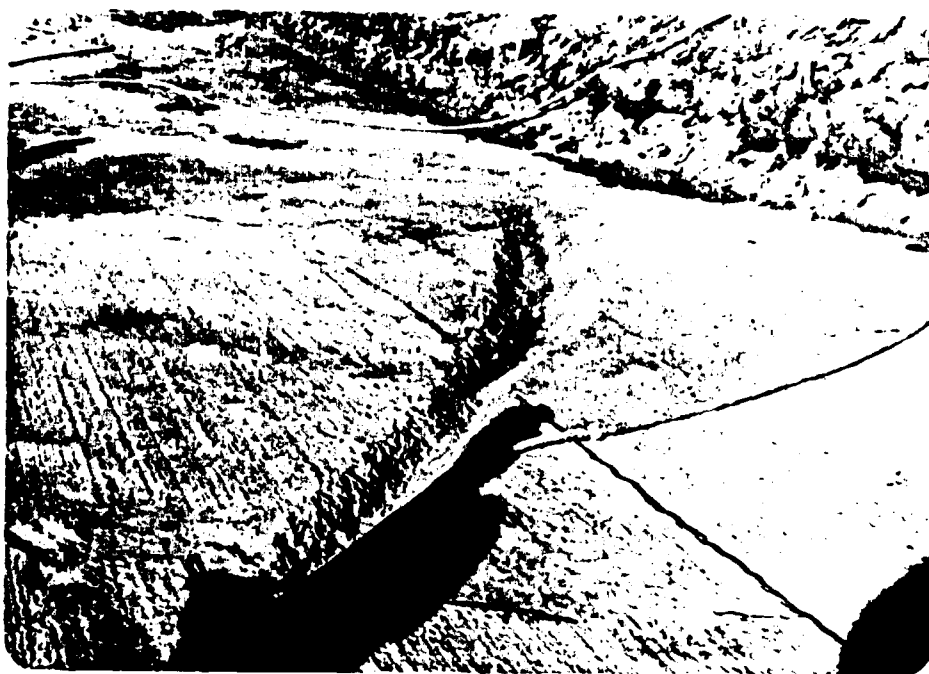
PHOTOGRAPHS



1. Longview Lake, 4 Dec 79, Neg. No. 1.
Left side outlet works excavation Station 50+77 to
to Station 50+87. Pleasanton Formation zones D and E.



2. Longview Lake, 4 Dec 79, Neg. No. 3.
Right side outlet works excavation Station 50+86.
Pleasanton Formation zone E.



3. Longview Lake, 4 Dec 79, Neg. No. 4.
Look right and downstream outlet works excavation.
Station 51+14 to Station 51+33. Dozer blade mark.



4. Longview Lake, 4 Dec 79, Neg. No. 5.
Look left and downstream. Outlet works excavation.
Station 51+14 to Station 51+33. Dozer blade mark.



5. Longview Lake, 4 Dec 79, Neg. No. 6.
Look downstream. Outlet works excavation at
Station 51+20. Pleasanton Formation zone E.



6. Longview Lake, 4 Dec 79, Neg. No. 7.
Outlet works excavation at Station 51+54. Pleasanton
Formation zone E.



7. Longview Lake, 4 Dec 79, Neg. No. 8.
On right side at Station 51+40. Look upstream.
Note NX core hole AC-221. Placing lean concrete in
background.



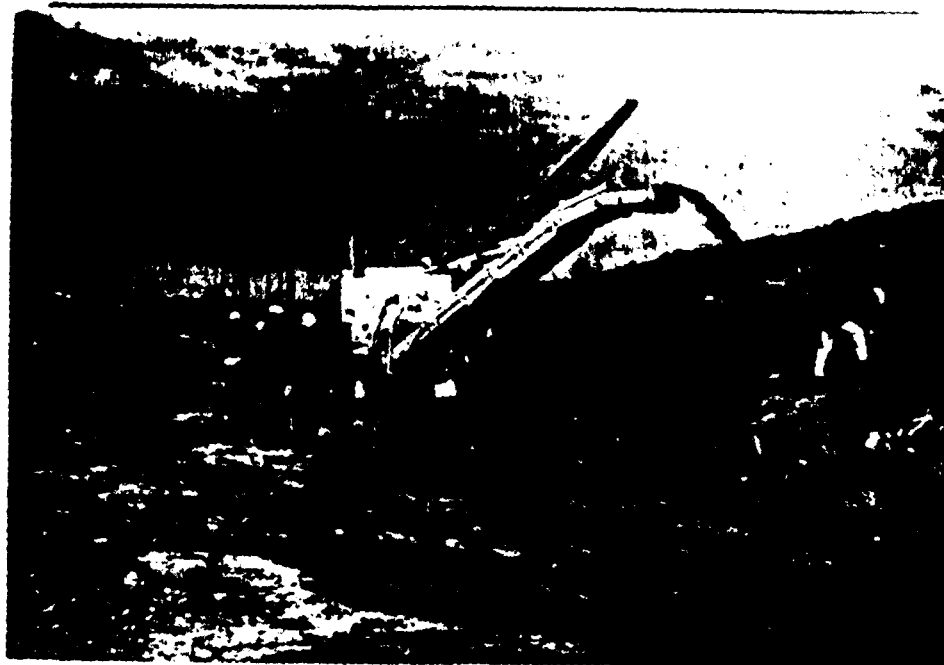
8. Longview Lake, 4 Dec 79, Neg. No. 9.
At Station 51+50. Look left and downstream.
Pleasanton zone E.



9. Longview Lake, 4 Dec 79, Neg. No. 10.
At Station 51+55 look left and downstream. Pleasanton
Formation zone E.



10. Longview Lake, 4 Dec 79, Neg. No. 13.
Track mounted "roto mill" used to excavate final
foundation surface.



11. Longview Lake, 4 Dec 79, Neg. No. 28.
Track mounted "roto mill" used to excavate final
foundation surface.



12. Longview Lake, 8 Dec 79,
Neg. No. 14.
Station 52+10, centerline.
Look left and downstream
Pleasanton Formation zone.



13. Longview Lake, 5 Dec 79, Neg. No. 16.
Station 52+35, centerline. Look left and downstream.
Pleasanton Formation zone E.



14. Longview Lake, 5 Dec 79, Neg. No. 17.
Station 52+48 left side. Look right and downstream.
Pleasanton Formation zone E.



15. Longview Lake, 5 Dec 79, Neg. No. 18.
Station 52+75 right side. Look left and stream in
Pleasanton Formation zone E.



16. Longview Lake, 5 Dec 79, Neg. No. 19.
Station 52+85, centerline. Look right and stream in
Pleasanton Formation zone E.



17. Longview Lake, 5 Dec 79, Neg. No. 23.
Station 52490, centerline. Look downstream.
Pleasanton Formation zone E.



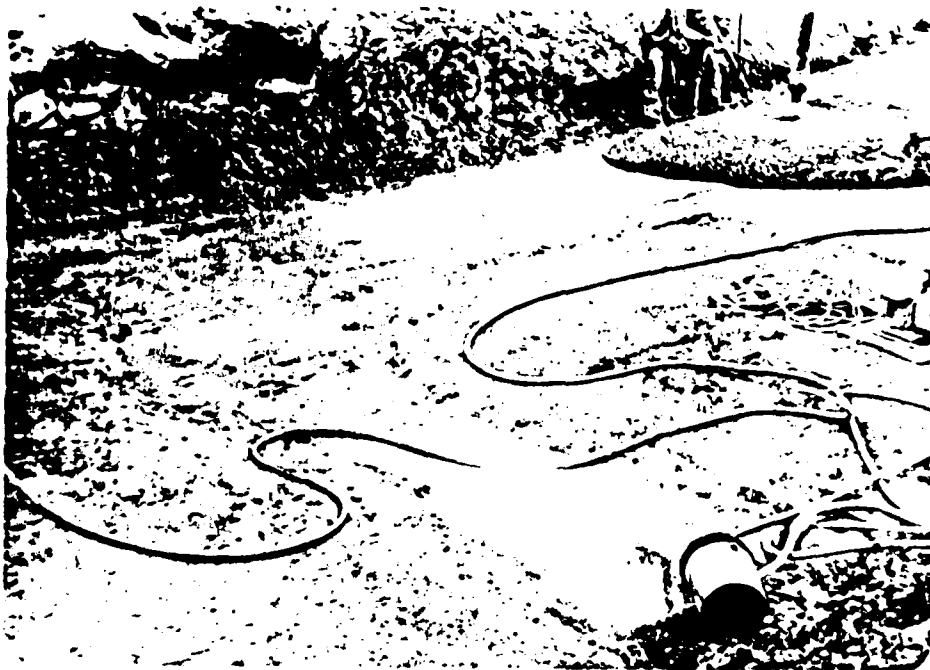
18. Longview Lake, 6 Dec 79, Neg. No. 25.
Station 53420, centerline. Look downstream.
Pleasanton Formation zone E.



19. Longview Lake, 6 Dec 79, Neg. No. 26.
At Station 53+40, centerline. Look left and down-
stream. Pleasanton Formation zone E.



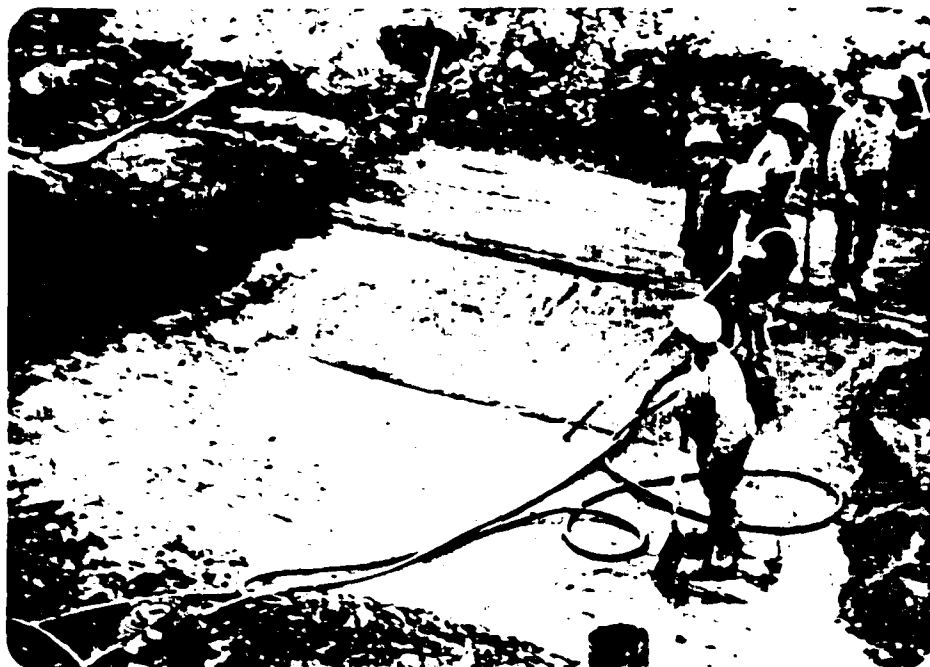
20. Longview Lake, 6 Dec 79, Neg. No. 27.
At right wall Station 53+40. Look left and downstream.
Pleasanton Formation zone E.



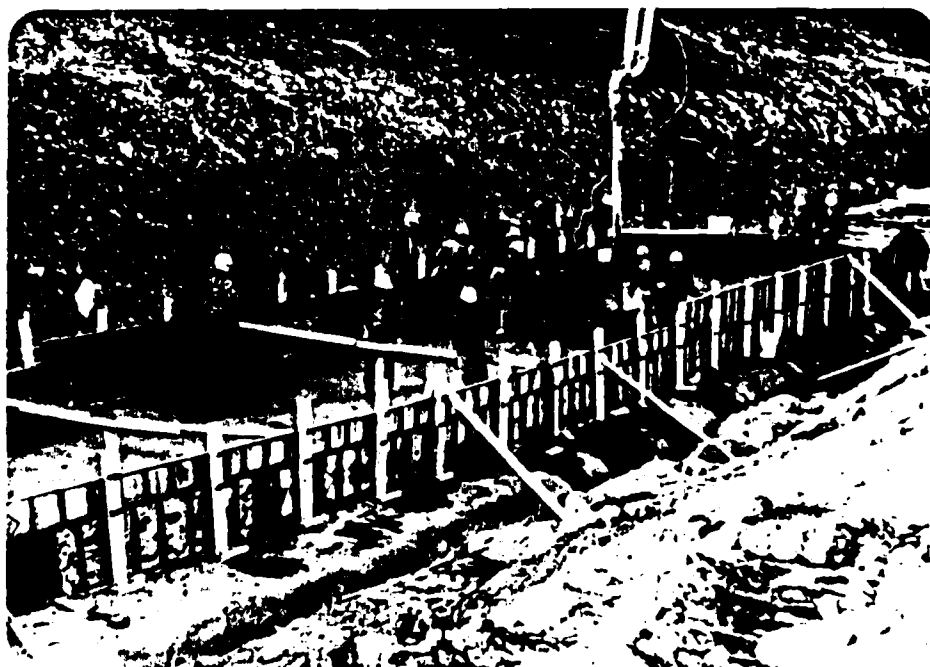
21. Longview Lake, 6 Dec 79, Neg. No. 28.
At left side Station 54+10. Look right and upstream.
Placing lean concrete.



22. Longview Lake,
6 Dec 79, Neg. No. 29.
At right side Station
53+95. Look left.
Pleasanton Formation
zone E.



23. Longview Lake, 6 Dec 79, Neg. No. 30.
At left side Station 54+00. Look right.



24. Longview Lake, 7 Dec 79, Neg. No. 32.
At right side Station 51+00. Look left and
downstream. Placing second layer of lean concrete.



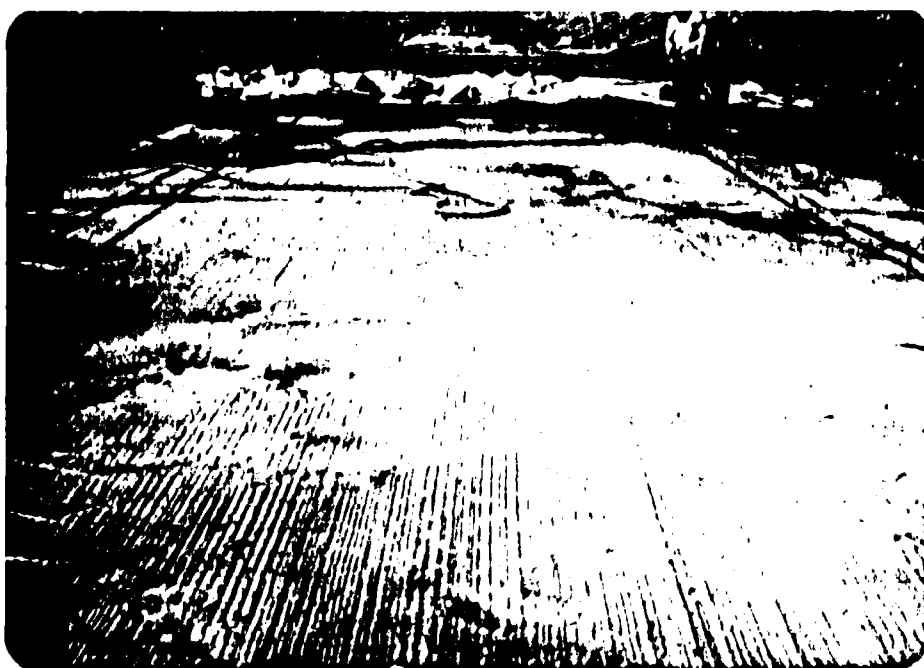
25. Longview Lake, 18 Feb 80, Neg. No. 33.
View of right abutment.



26. Longview Lake, 5 Mar 80, Neg. No. 57.
Look west at slide on left side outlet works
excavation Station 55+00* to Station 57+00* - slide
occurred 18 Nov 79 estimated volume 3000* cu yd.



27. Longview Lake, 24 Mar 80, Neg. No. 98.
Look west at slides on left side outlet works
excavation near dam. Slides occurred 23 Mar 80.



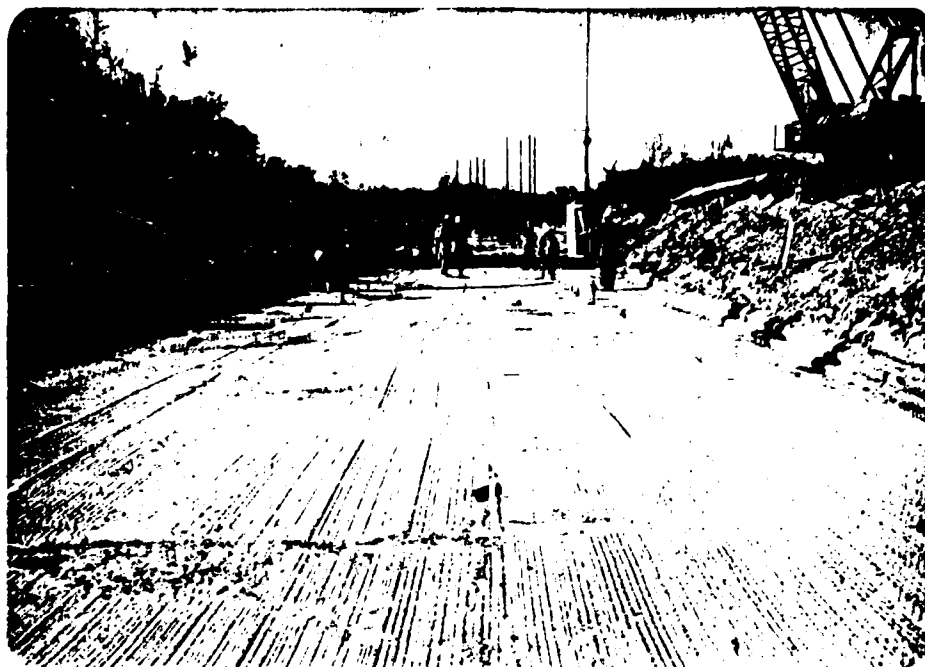
28. Longview Lake, 9 Apr 80, Neg. No. 11.
At Station 48+72, centerline. Look down road.
Pleasanton Formation in D. Road some 100
yards.



29. Longview Lake, 9 Apr 80, Neg. No. 114.
At Station 46+15, centerline. Look downstream.
Pleasanton Formation zone D.



30. Longview Lake, 9 Apr 80, Neg. No. 115.
At Station 46+47, centerline. Look downstream.
Pleasanton Formation zone D.



31. Longview Lake, 9 Apr 80, Neg. No. 116.
At Station 47+48, centerline. Look downstream.
Pleasanton Formation zone D.



32. Longview Lake, 9 Apr 80, Neg. No. 117.
At Station 48+49, centerline. Look downstream.
Pleasanton Formation zone D.



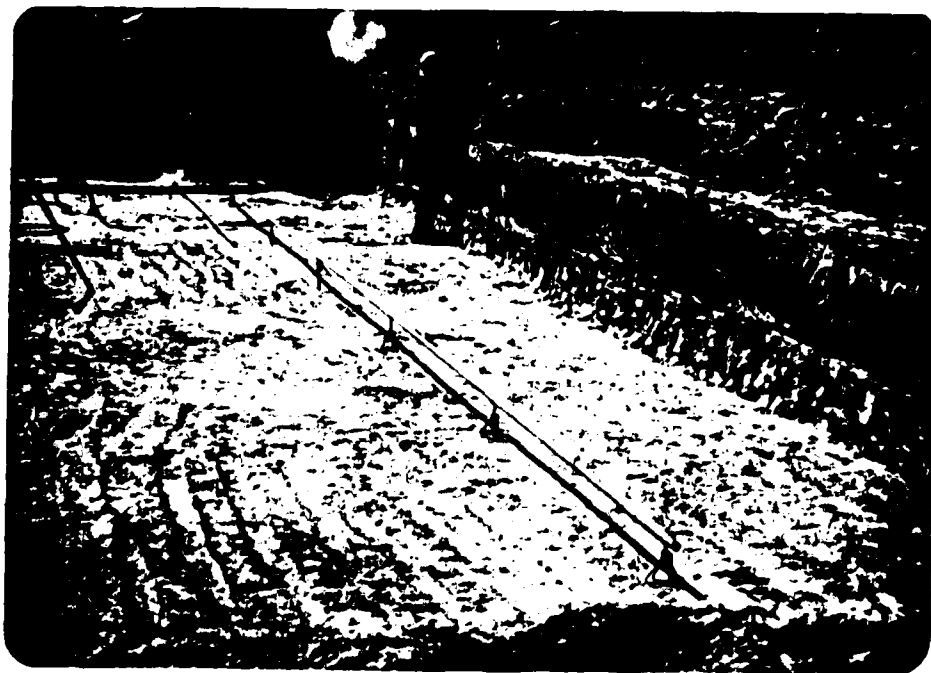
33. Longview Lake, 10 Apr 80, Neg. No. 119.
At Station 46+32, centerline. Look upstream.
Pleasanton Formation zone D.



34. Longview Lake, 16 Apr 80, Neg. No. 123.
Rock saw used for vertical cuts in intake tower
area.



35. Longview Lake, 22 Apr 80, Neg. No. 134.
At Station 45+97, centerline. Look upstream at
right side. Pleasanton Formation zone C.

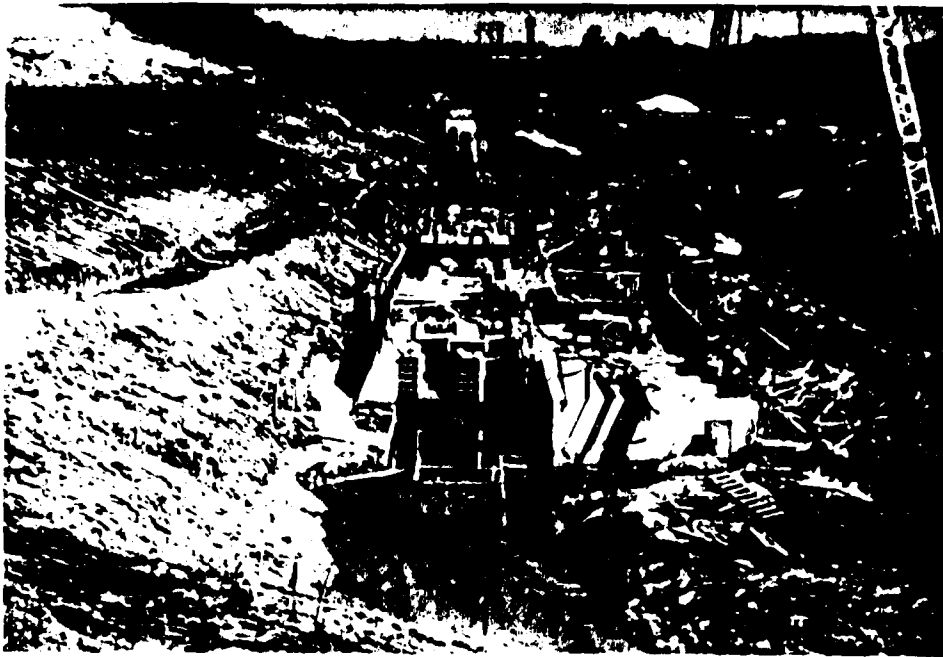


36. Longview Lake, 22 Apr 80, Neg. No. 135.
At Station 45+97, centerline. Look upstream at left
side, rock saw working in background.



37. Longview Lake, 22 May 80, Neg. No. 165.
At Station 55+40, centerline. Look upstream.
Pleasanton Formation zone E.





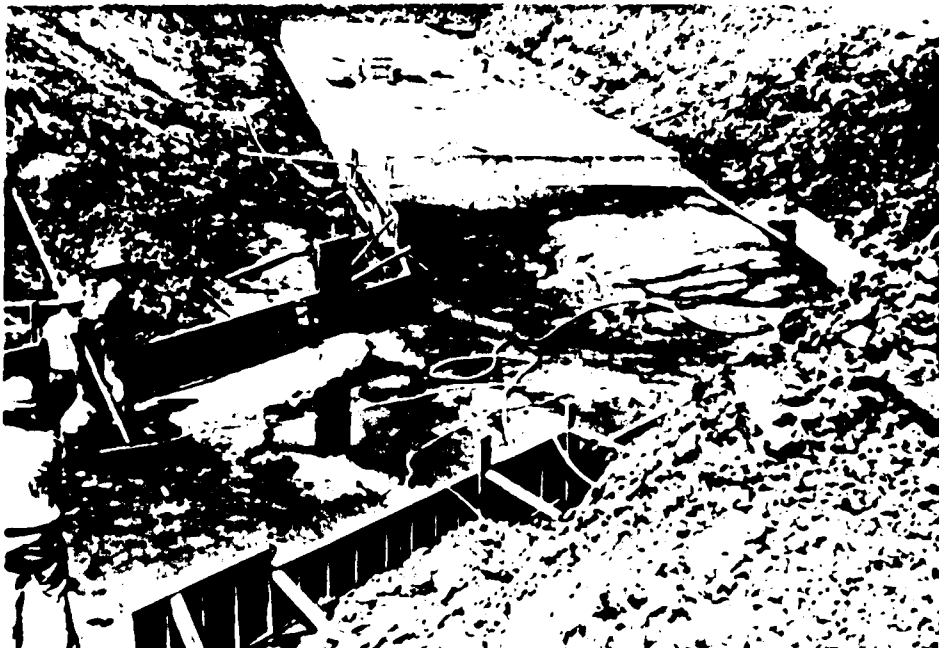
39. Longview Lake, 23 Jun 80, Neg. No. 228.
Camera at O.W. Station 44+55. Look downstream at
outlet work.



40. Longview Lake, 30 Jul 80, Neg. No. 642.
Camera at O.W. Station 44+30, range 18' left.
View of concrete enclosed temperature
recording "pump" before new cover
is installed.



(c) Longview Lake, 10 Jul 80, Neg. No. 643.
 Camera at O.W. Station 54+70+ range 78' right.
 Look upstream at "inverted siphon," before new
 sewer construction.



(d) Longview Lake, 22 Aug 80, Neg. No. 309.
 Camera at Station 54+50 range 70' right. Look
 upstream at "inverted siphon" sewer foundation.
 (Note construction road in foreground.)

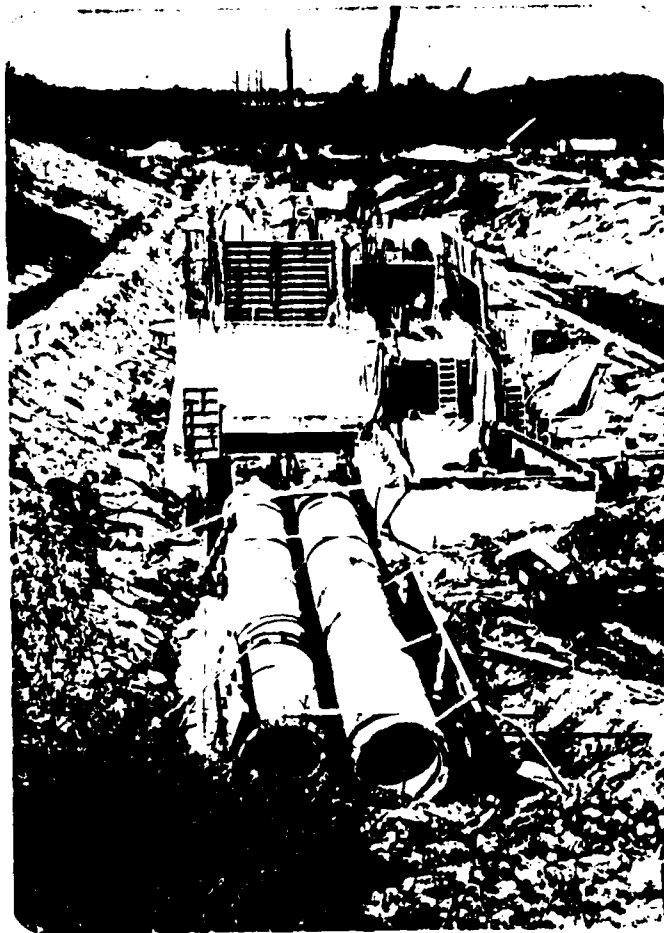


Fig. 1. Launching of the "Soyuz" rocket from the "Soyuz" launch complex.



Fig. 2. Launching of the "Soyuz" rocket from the "Soyuz" launch complex.

Figure 1. (a) Lake, 23 Sep 80, Neg. No. 223.
 (b) Lake, 23 Sep 80, Neg. No. 224.
 (c) Lake, 23 Sep 80, Neg. No. 225.

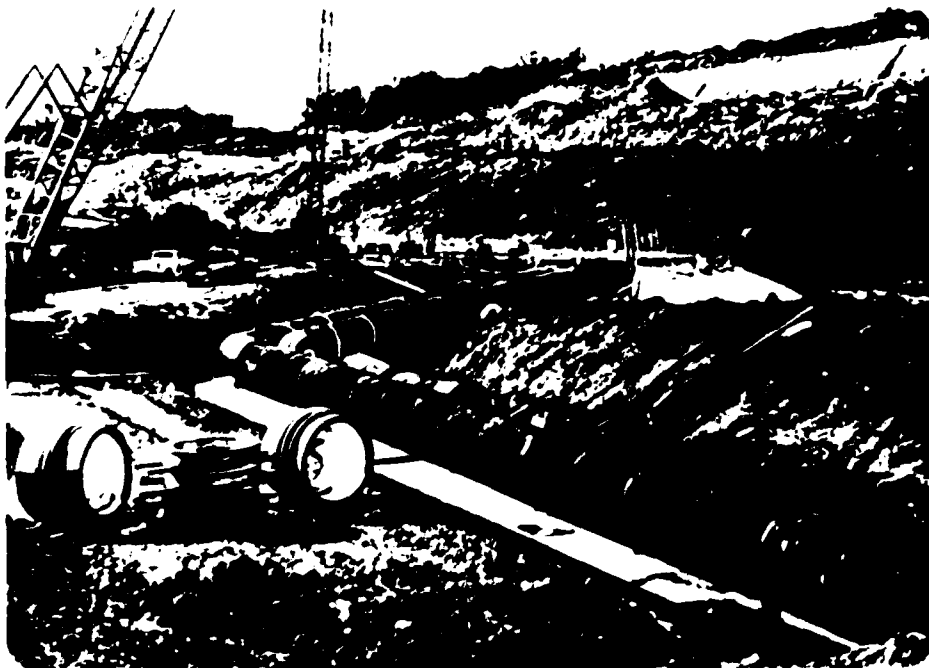


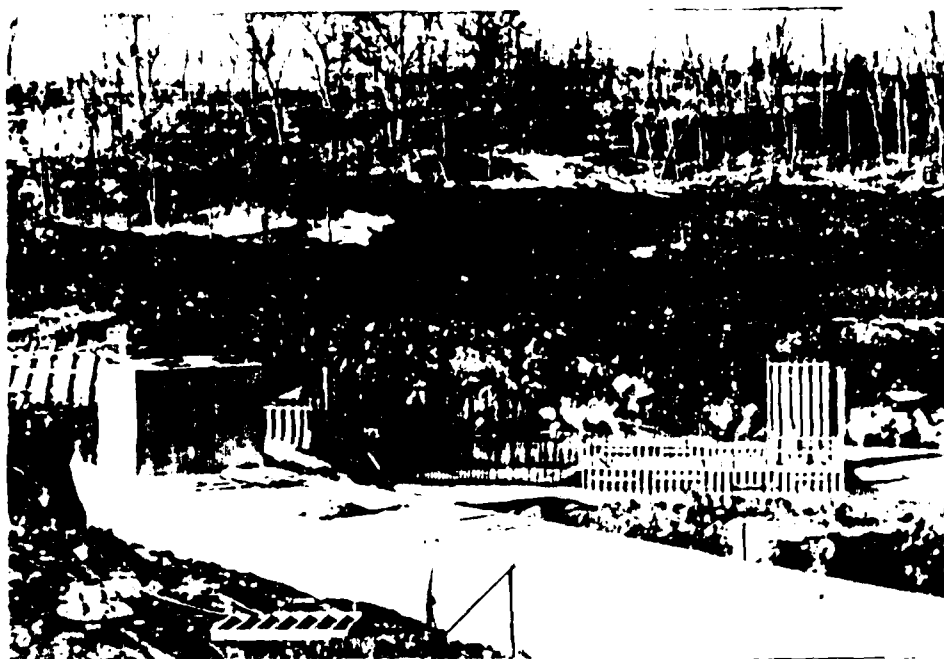
Figure 2. (a) Lake, 23 Sep 80, Neg. No. 223.
 (b) Lake, 23 Sep 80, Neg. No. 224.
 (c) Lake, 23 Sep 80, Neg. No. 225.



c. Longview Lake, 3 Nov 80, Neg. No. 261.
Camera at O.W. Station 44+80', range 60' left.
Look east. Backfill round intake tower.



d. Longview Lake, 1 Dec 80, Neg. No. 262.
Look west at slides on left side of outlet works
excavation. This is same area of slides which
occurred on 23 Mar 80. See Photo 2.



19. Longview Lake, 17 Feb 81, Neg. No. 531.
Camera at O.W. Station 55+50±, range 90' right.
Look west at repaired slide area. See also photo 26.



20. Longview Lake, 18 Apr 81, Neg. No. 947.
O.W. Station 510'± on left side. Look down at
excavation channel prior to placement of
concrete. Foundation foundation.



sl. Longview Lake, 28 Apr 81, Neg. No. 645.
O.W. Station 51+25 on left side. Look downstream.
Foundation cleanup. Pleasanton Formation zone 1.



Longview Lake, 1 Jun 81, Neg. No. 706.
O.W. Station 52+35 on right side. Look downstream.
Foundation cleanup. Pleasanton Formation zone 1.



53. Longview Lake, 1 Jun 81, Neg. No. 707.
O.W. Station 48+00± on right side. Look
downstream. Placing pervious drain backfill
material.



54. Longview Lake,
Neg. No. 708.
O.W. Station 47+20±
road 180° right.
Look NW. Foundation
of old sewer
conduit. Pleasanton
Township, Jones A. 101.



55. Longview Lake,
17 Jul 81, Neg. No. 875.
O.W. Station 55+10±, ran
50'± right. Look upstre
at temporary, concrete
encased, 20-inch diameter,
sewer line, "inverted
siphon," after new sewer
construction.



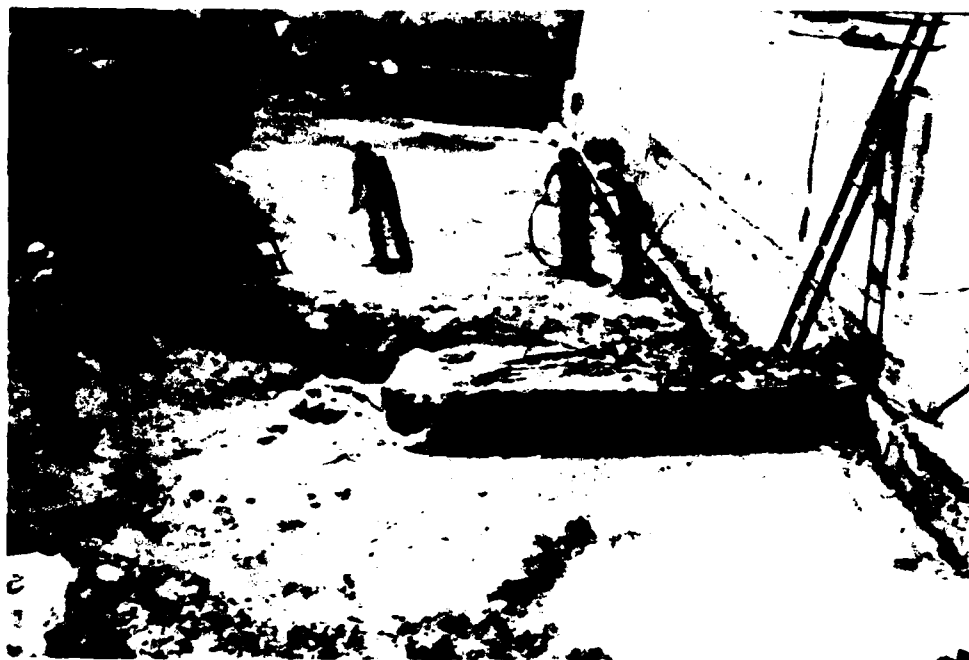
56. Longview Lake, 17 Jul 81, Neg. No. 903.
O.W. Station 55+51±, ran 80'± right. Look
downstream at "Inverted Siphon," after
sewer construction.



57. Longview Lake, 17 Jul 81, Neg. No. 905.
O.W. Station 55+00±, range 40'± right. Look
upstream and "inverted siphon." Men covering
Pipe with filter cloth.



58. Longview Lake,
17 Jul 81, Neg. No. 906.
O.W. Station 54+67±, range
40' right. Look downstream
at "inverted siphon."
Men covering pipe with
filter cloth.



59. Longview Lake, 20 Jul 81, Neg. No. 911.
O.W. Station 54+70±, range 80' right. Look upstream
and left. Cleanup on upstream side of new sewer.



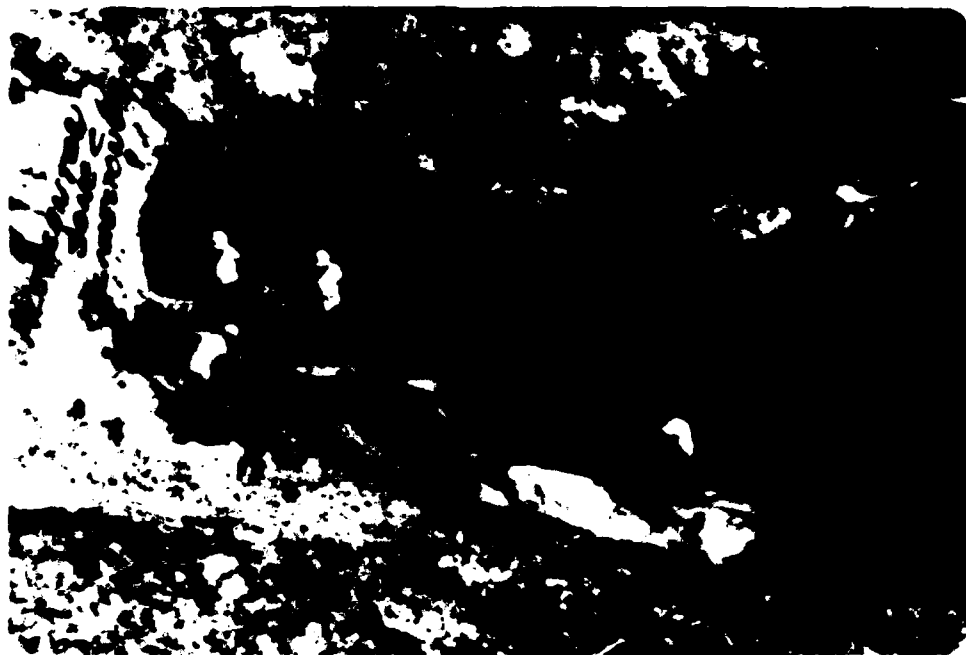
60. Longview Lake, 21 Jul 81, Neg. No. 912.
O.W. Station 54+25± centerline. Look right.
Cleanup on upstream side of new sewer.



61. Longview Lake, 21 Jul 81, Neg. No. 913.
O.W. Station 54+30± centerline. Look right. Men
placing pervious backfill on upstream side of new
sewer.



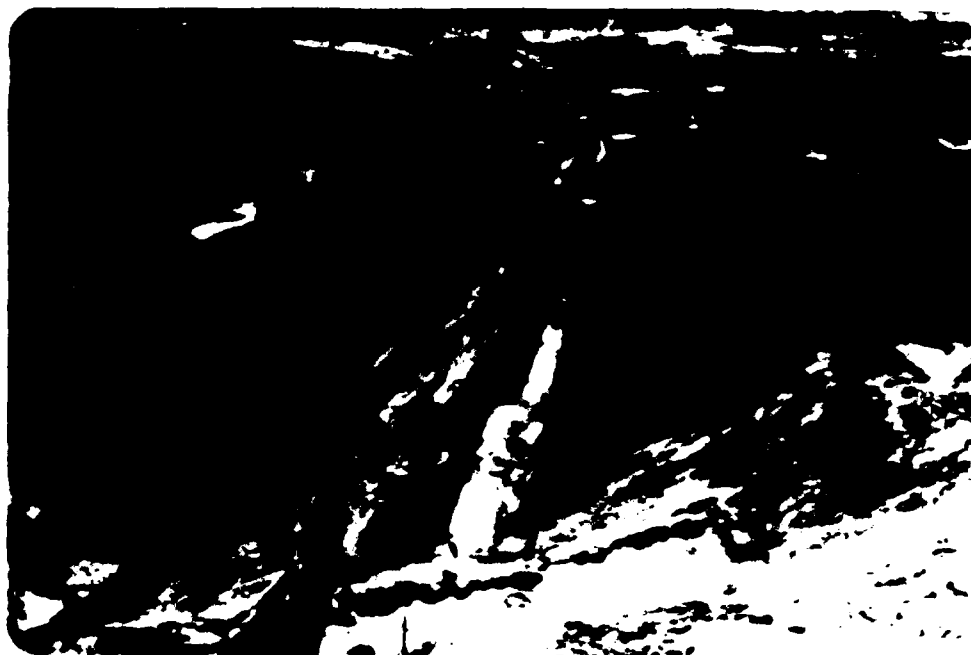
62. Longview Lake, 21 Jul 81, Neg. No. 914.
O.W. Station 55+05±, near 55+00± right side.
Look at outlet works.



63. Longview Lake, 10 Jun 80, Neg. No. 2.
Cutoff trench Station 89+85, range 50'± D.S.
Look upstream. Men placing pervious drain.



64. Longview Lake, 10 Jun 80, Neg. No. 8.
Cutoff trench Station 90+00 center line
southeast. Placing pervious drain.



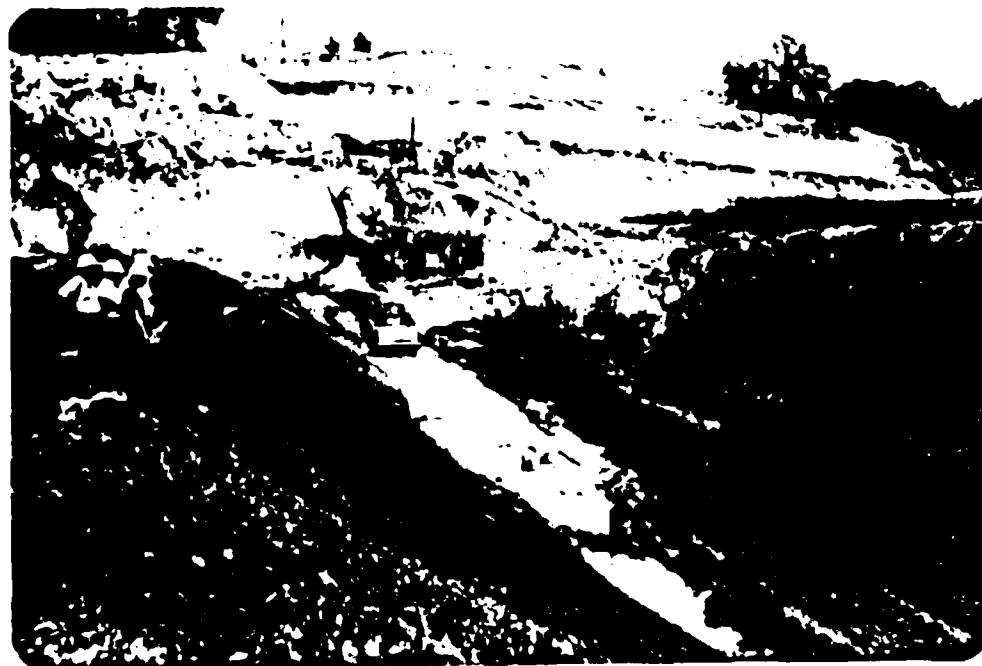
67. Bonview Lake, 10 Jun 80, Near Station 89+50, trench Station 89+50, ramp 100 ft. Look west. Preparing for placement of concrete.



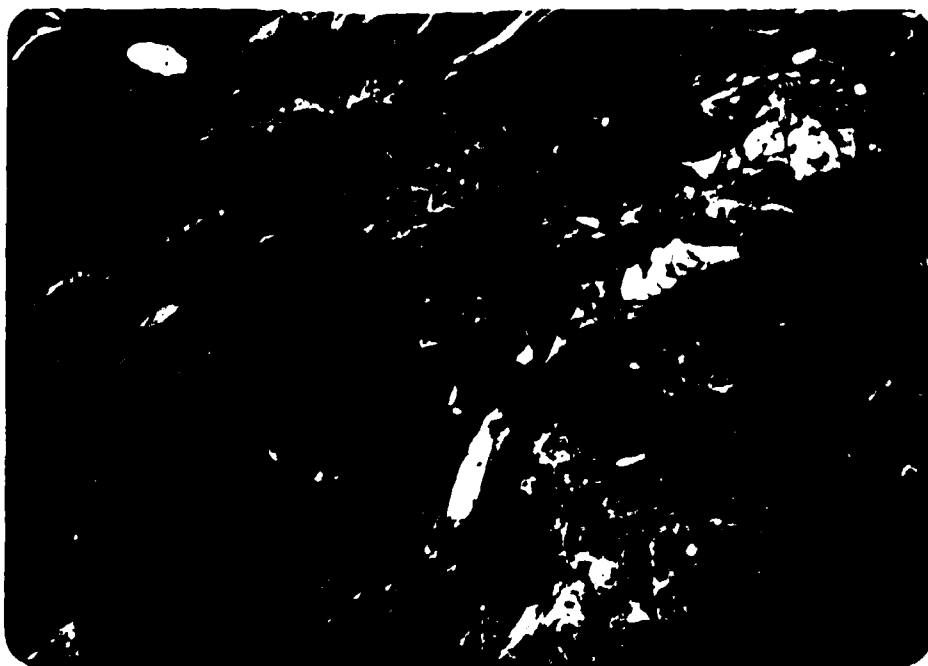
68. Bonview Lake, 10 Jun 80, Near Station 89+50, trench Station 89+50, ramp 100 ft. Look west. Preparing for placement of concrete.



65. Longview Lake, 10 Jun 80, Neg. No. 22.
Cutoff trench Station 90+70, range 10' ± D/S. Look
southeast. Preparing for placement of pervious drain.



66. Longview Lake, 10 Jun 80, Neg. No. 23.
Cutoff trench Station 90+70, range 10' ± D/S. Look
southeast. Same area as photo 65.



69. Longview Lake, 12 Jul 80, Neg. No. 238.
Cutoff trench Station 89+40. Look at downstream
slope. Pleasanton zone B shale.



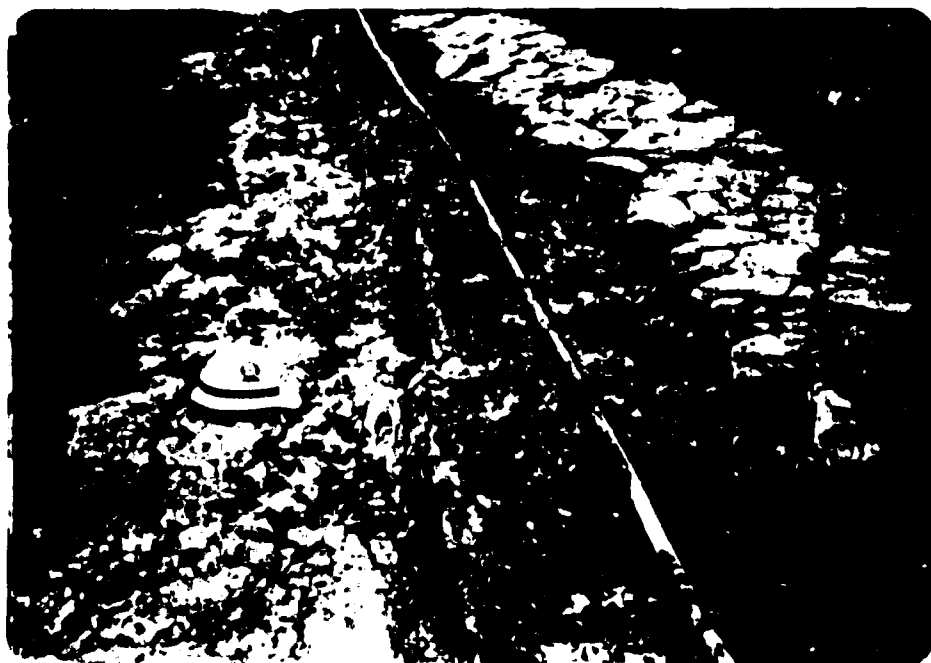
70. Longview Lake, 30 Jul 80, Neg. No. 239.
Look at cutoff and look at bottom of trench.



Chavew Lake, 30' and 80' from Nov. 80. Look west. Left abutment in background with right abutment in foreground.



Chavew Lake, 10' and 80' from Nov. 80. Look west. Right abutment in background. 80' and 200' up stream from right abutment. Right abutment in foreground.



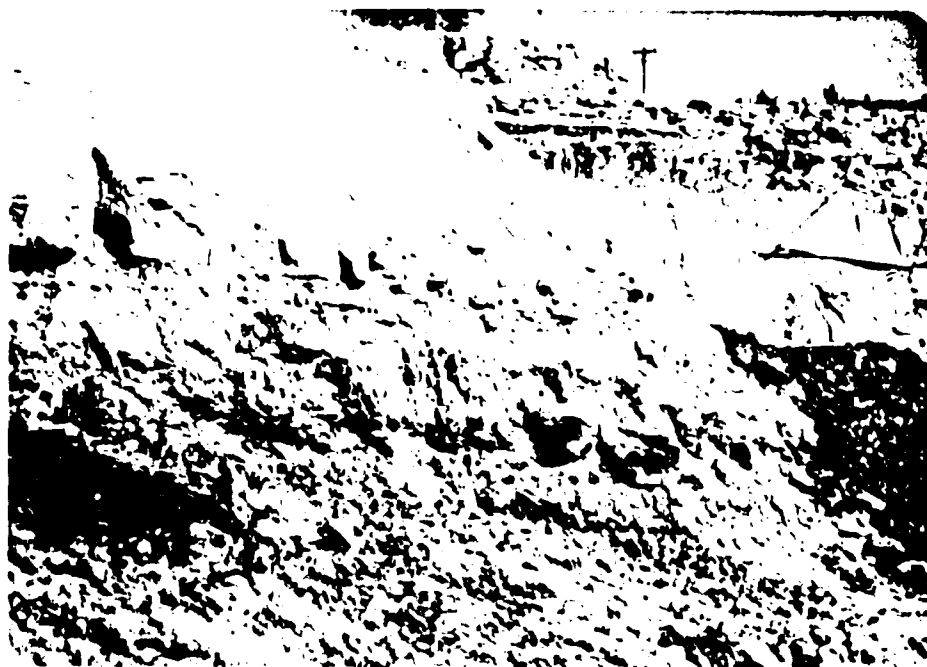
3. Longview Lake, 14 Aug 80, Neg. No. 224.
Station 85410, range 460' upstream. Look downstream
and the creek limestone.



4. Longview Lake, 14 Aug 80, Neg. No. 217.
Station 85410, range 460' upstream. Look downstream,
"creek limestone" on Middle Creek L.



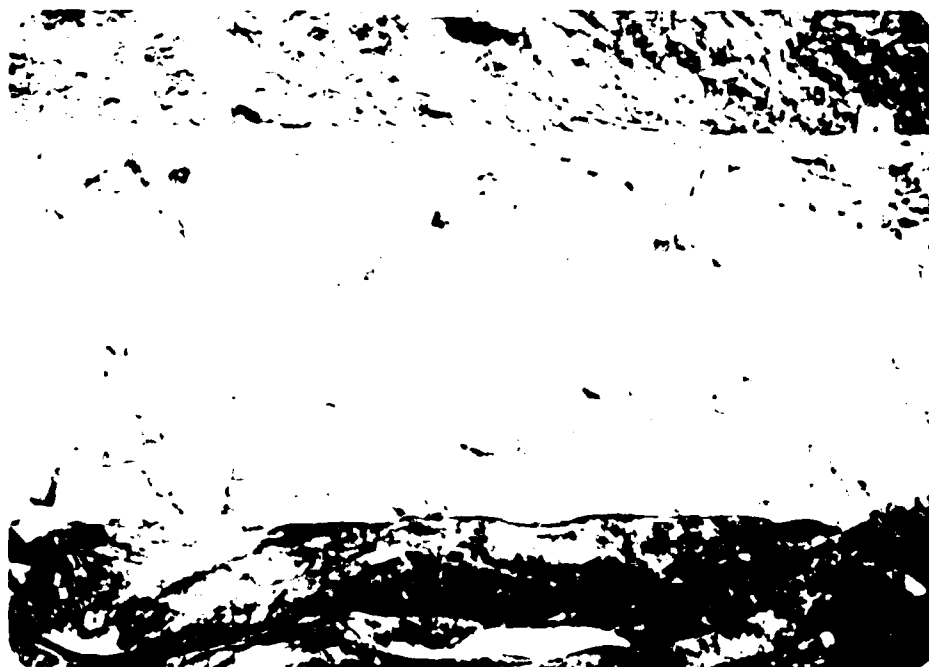
75. Longview Lake, 14 Aug 80, Neg. No. 215.
Station 85+10, range 460' upstream. Look downstream.
Slush fronting Middle Creek Is.



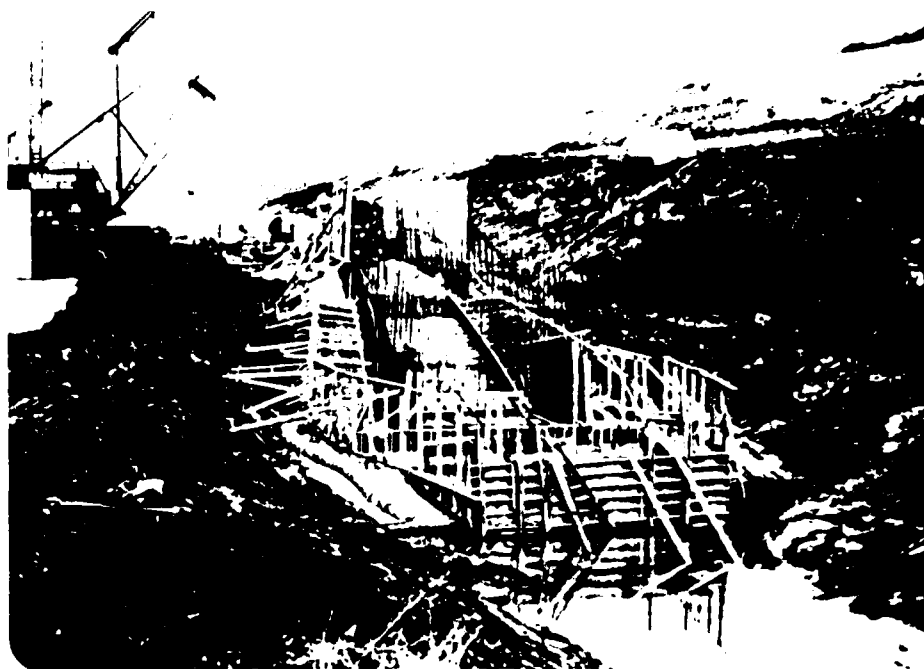
76. Longview Lake, 14 Aug 80, Neg. No. 216.
Station 85+10, range 460' upstream. Look east at
Middle Creek Is. and the dam in the distance.



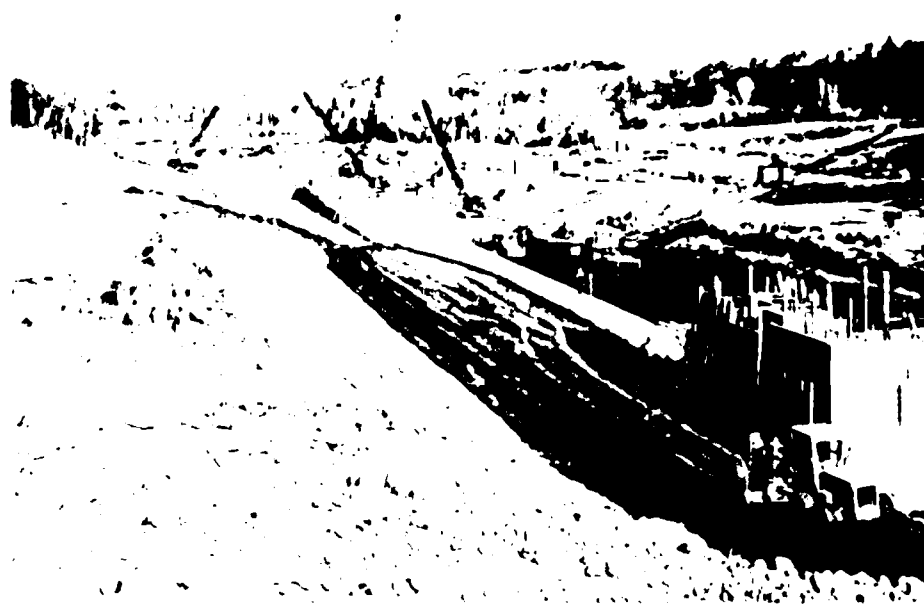
77. Longview Lake, 13 Oct 80, Neg. No. 347.
Right abutment Station 89+00. Look east at
Pleasanton zone A sandstone.



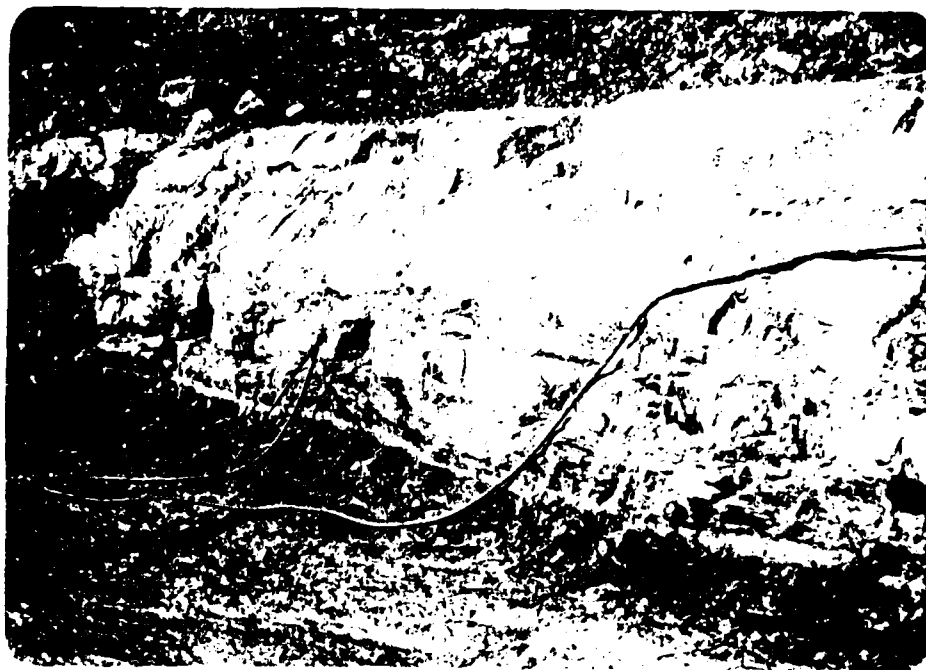
78. Longview Lake, 13 Oct 80, Neg. No. 348.
Right abutment Station 89+00. Look east at
Pleasanton zone A sandstone.



29. Longview Lake, 17 Nov 80, Neg. No. 403.
Look upstream at outlet works construction.



30. Longview Lake, 18 Nov 80, Neg. No. 426.
Look downstream at outlet works construction.



81. Longview Lake, 19 Nov 80, Neg. No. 431.
Station 88+40. Look downstream at Sniabar limestone.



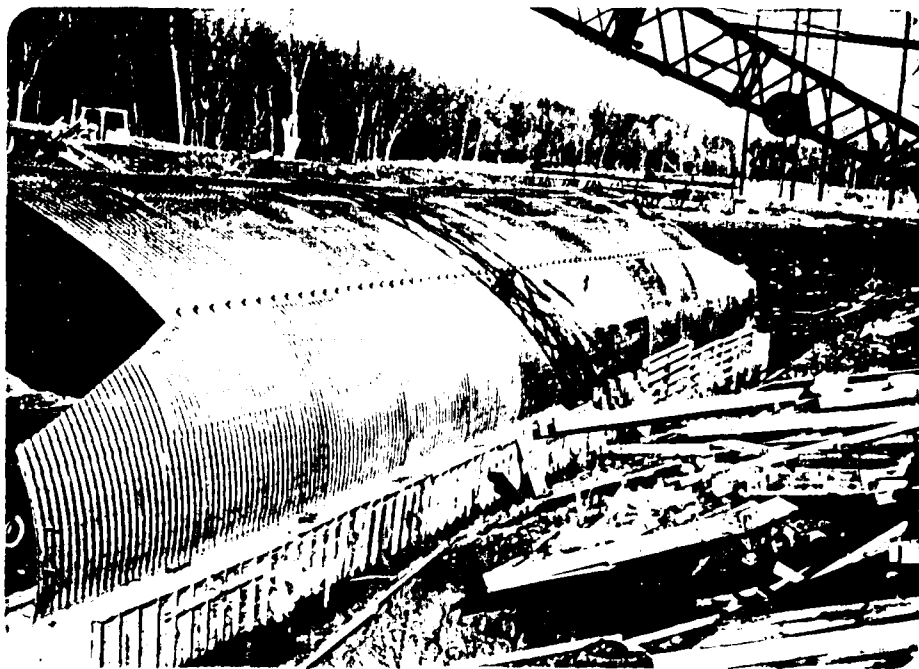
82. Longview Lake, 15 Dec 80, Neg. No. 467.
Station 87+80. Look downstream at Bethany Falls
LS and Hushpuckney Shale.

86. Longview Lake, 15 Dec 80, Neg. No. 470.
Station 87+80+. Look upstream between falls
limestone and Hushpuckney Shale.



83. Longview Lake, 15 Dec 80, Neg. No. 469.
Station 87+80. Joints in lower 2½ feet of
Hushpuckney Shale.





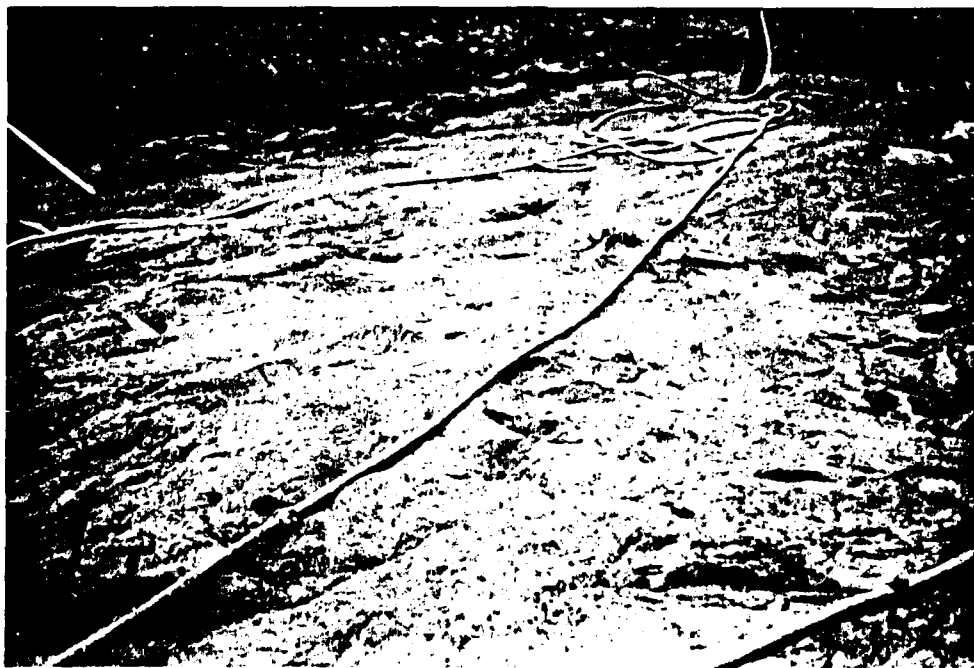
85. Longview Lake, 22 Jan 81, Neg. No. 517.
Construction of bridge over outlet channel.



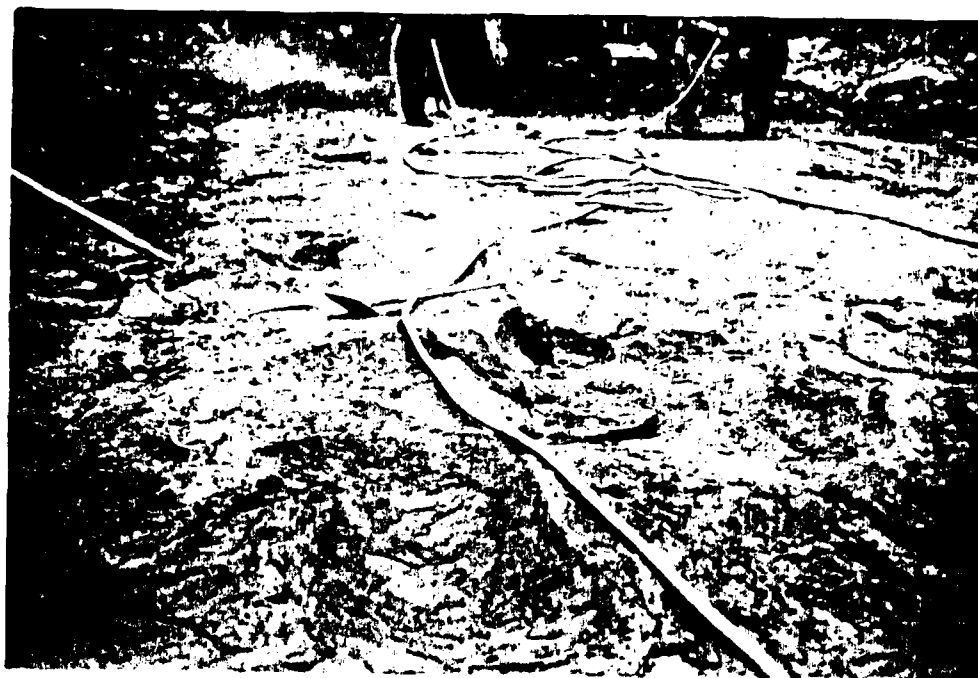
86. Longview Lake, 19 Mar 81, Neg. No. 591.
Station 87+85 right abutment look at downstream
corner of cutoff trench. Bethany Falls Limestone
and Hushpuckney Shale.



87. Longview Lake, 4 Apr 81, Neg. No. 613.
Station 97+95. From old 48-inch sewer look east
at 6-inch core hole AC-21. Pleasanton zone D.



88. Longview Lake, 4 Apr 81, Neg. No. 615.
Station 97+83. Look east and downstream at
Pleasanton zone D.



89. Longview Lake, 4 Apr 81, Neg. No. 616.
Station 97+15. Look east Pleasanton zone D.



90. Longview Lake, 4 Apr 81, Neg. No. 617.
Station 97+65. Look west at old 48-inch sewer
pipe at Station 97+95.



91. Longview Lake, 4 Apr 81, Neg. No. 618.
Station 97+65. Look west at old 48-inch sewer.



92. Longview Lake, 4 Apr 81, Neg. No. 619.
Station 97+83. Look upstream and east.



93. Longview Lake, 4 Apr 81, Neg. No. 620.
Station 97+83. Look upstream Pleasanton zone D.



94. Longview Lake, 4 Apr 81, Neg. No. 622.
Station 97+75, range 20 U/S. Look upstream at
calcareous nodules in Pleasanton zone D.



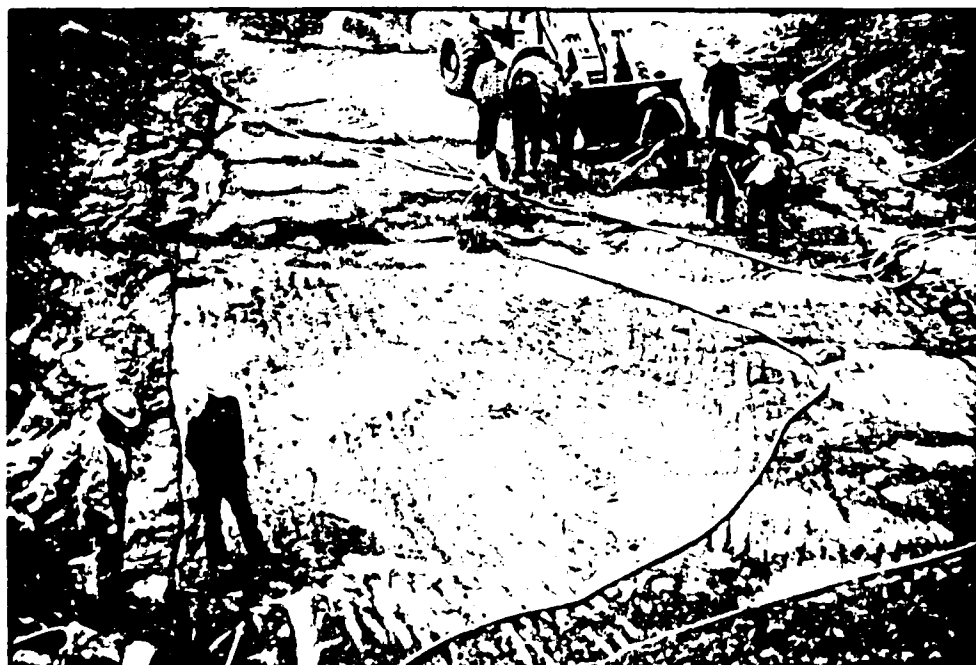
95. Longview Lake, 4 Apr 81,
Neg. No. 622.
Station 96+00. Look
west Pleasanton zone D.



96. Longview Lake, 4 Apr 81, Neg. No. 623.
Station 97+25. Look east Pleasanton zone D.



97. Longview Lake, 4 Apr 81, Neg. No. 625.
Station 96+60. Look upstream and left Pleasanton zone D.



98. Longview Lake, 4 Apr 81, Neg. No. 626.
Station 95+75. Look west Pleasanton zone D.



99. Longview Lake, 4 Apr 81, Neg. No. 627.
Station 96+50. Look southeast Pleasanton zone D.



100. Longview Lake, 4 Apr 81, Neg. No. 628.
Station 96+70. Look southwest Pleasanton zone D.



101. Longview Lake, 4 Apr 81, Neg. No. 629.
Station 96+25. Look east Pleasanton zone D.



102. Longview Lake, 4 Apr 81, Neg. No. 630.
Station 96+20. Look northeast.



103. Longview Lake, 2 May 81, Neg. No. 651.
Station 98+70. Look west at base of Pleasanton
zone C.



104. Longview Lake, 2 May 81, Neg. No. 652.
Station 98+70. Look west at base of Pleasanton
zone C.



105. Longview Lake, 2 May 81, Neg. No. 653.
Station 98+70. Look west at base of Pleasanton
zone C.



106. Longview Lake, 6 Jul 81, Neg. No. 654.
Look downstream at foundation cleanup of old sewer.



107. Longview Lake, 13 Jul 81, Neg. No. 869.
Look downstream along right side of outlet works.



108. Longview Lake, 14 Jul 81, Neg. No. 870.
Station 98420. Look east Pleasanton zone D.



109. Longview Lake, 14 Jul 81, Neg. No. 871.
Station 98+00. Look west toward conduit.



110. Longview Lake, 14 Jul 81, Neg. No. 872.
Station 97+80. Look west toward conduit.

NO-A185 188

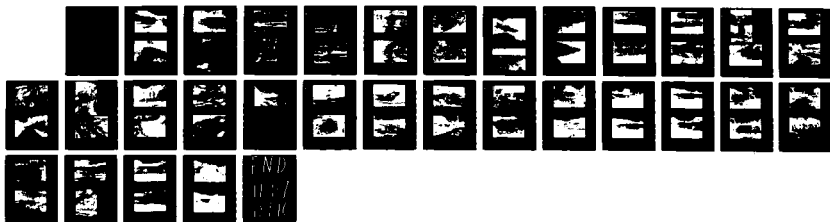
MULTIPLE-PURPOSE PROJECT LITTLE BLUE RIVER BASIN LITTLE
BLUE RIVER MISSOU. (U) CORPS OF ENGINEERS KANSAS CITY
NO KANSAS CITY DISTRICT V ANDERSON ET AL. FEB 86

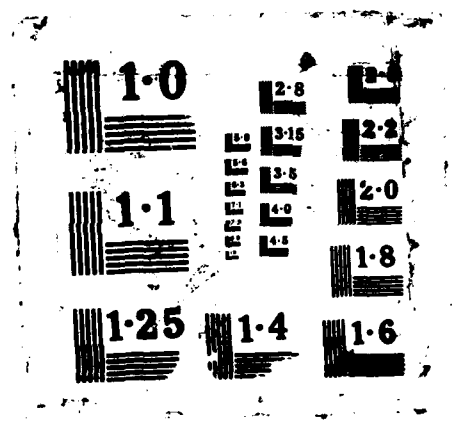
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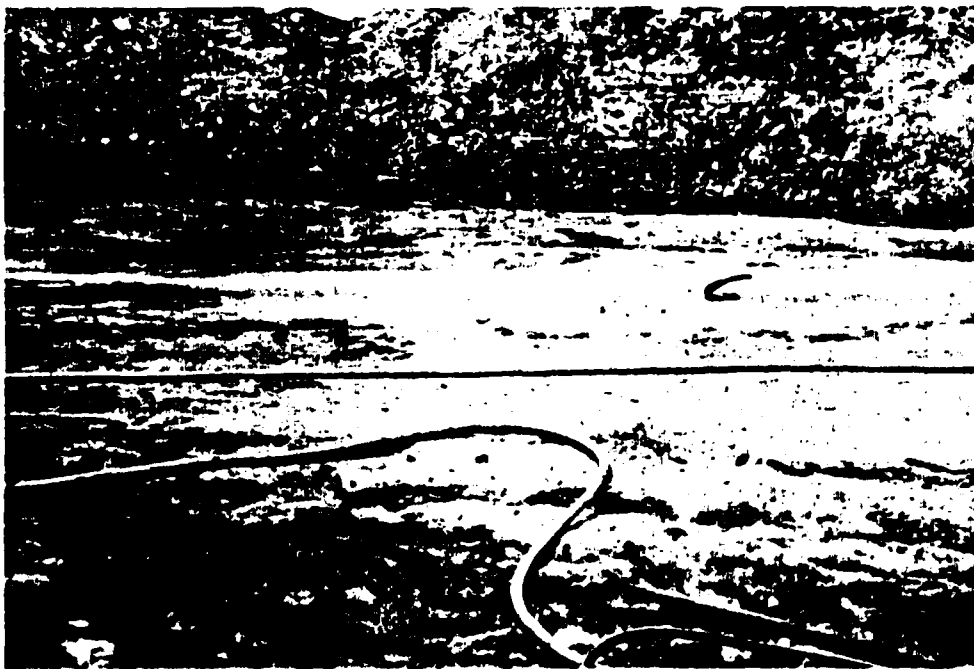




111. Longview Lake, 22 Jul 81, Neg. No. 922.
Station 98+80. Look downstream along left side
of conduit.



112. Longview Lake, 22 Jul 81, Neg. No. 924.
Station 99-05. Look downstream along left side of
conduit.



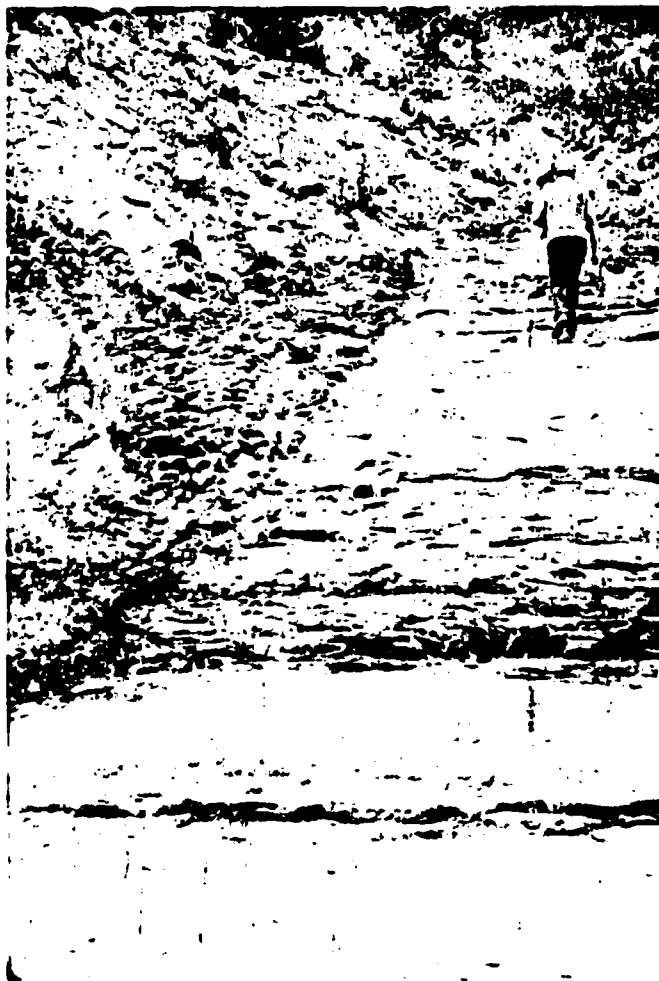
113. Longview Lake, 24 Jul 81, Neg. No. 929.
Station 99+20. Look west contact of Pleasanton
zone B shale and zone C argillaceous limestone.



114. Longview Lake,
30 Jul 81, Neg. No. 943.
Station 99+50. Look
upstream Pleasanton
zone B.



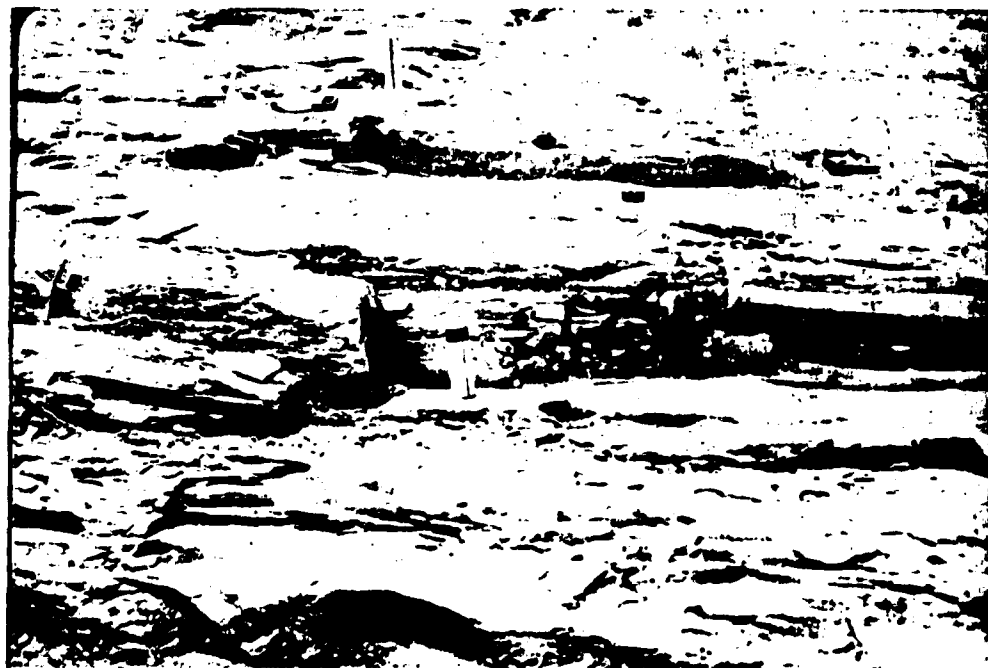
115. Longview Lake, 30 Jul 81, Neg. No. 944.
Station 99+43±. Look west Pleasanton zone B.



116. Longview Lake,
30 Jul 81, Neg. No. 945.
Station 99+43±. Look
west Pleasanton zone B.



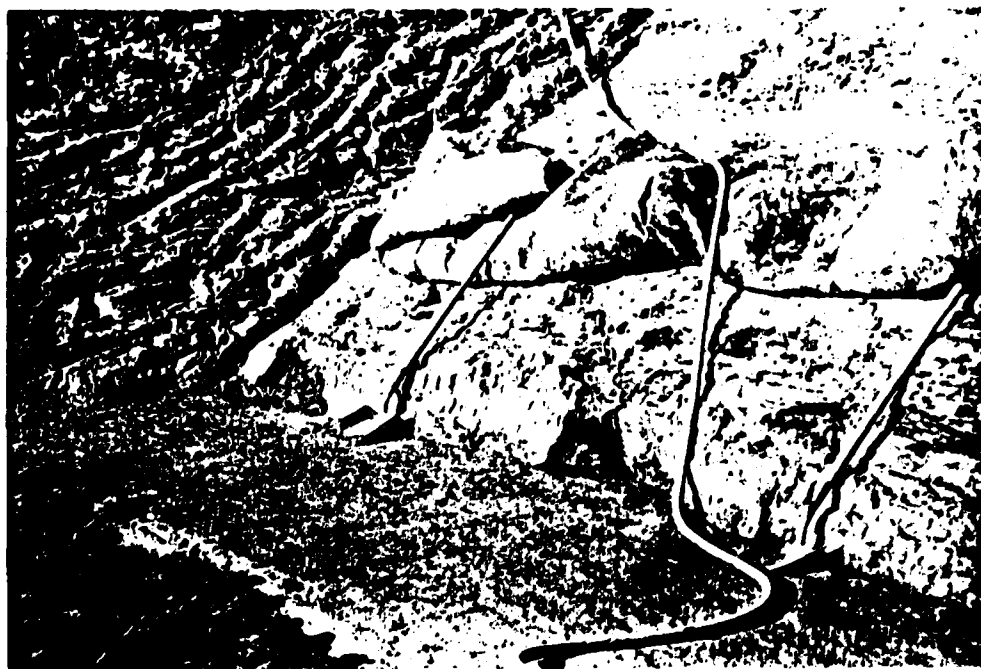
117. Longview Lake,
30 Jul 81, Neg. No. 946.
Station 99+43±. Look
west Pleasanton zone B.



118. Longview Lake, 30 Jul 81, Neg. No. 947.
Station 99+43±. Look west Pleasanton zone B.



119. Longview Lake, 18 Aug 81, Neg. No. 1021.
Station 99+80. Look west Pleasanton zone B.



120. Longview Lake, 19 Aug 81, Neg. No. 1023.
Station 99+95. Look upstream Pleasanton zone B.



121. Longview Lake, 19 Aug 81, Neg. No. 1024.
Station 99+95. Look downstream Pleasanton zone B.



122. Longview Lake, 19 Aug 81, Neg. No. 1025.
Station 99+75 range 30' U/S. Look downstream.

124. Longview Lake, 26 Aug 81, Neg. No. 1038.
Station 99+60 range 30' U/S. Look downstream.



123. Longview Lake, 19 Aug 81, Neg. No. 1026.
Station 99+70 centerline. Look upstream subcrop
of Pleasanton zone B.





125. Longview Lake, 27 Aug 81, Neg. No. 1011.
Station 99+75. Look west Pleasanton zone A and B.



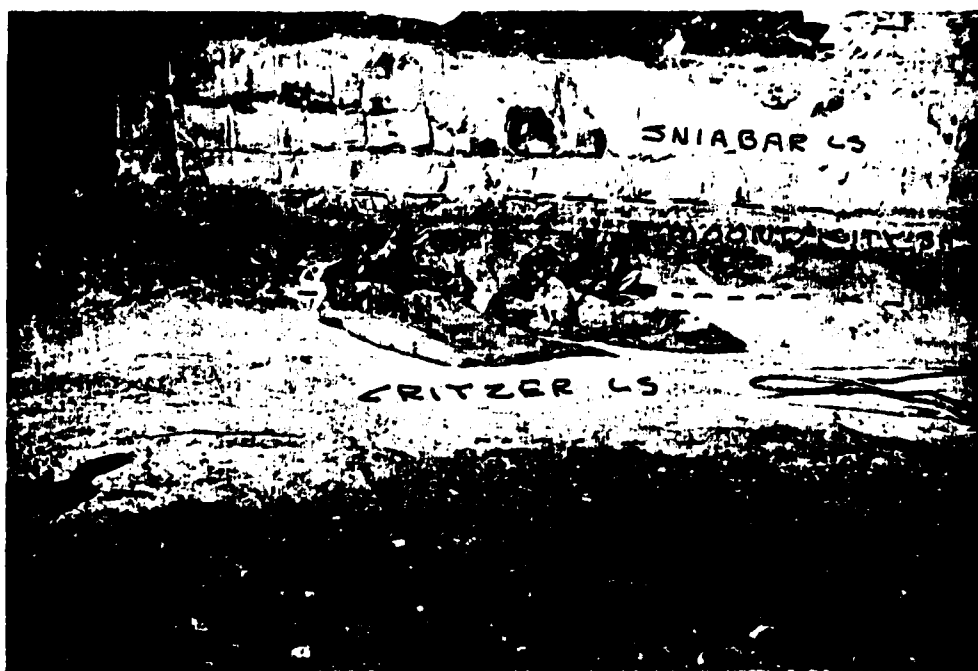
126. Longview Lake, 4 Sep 81, Neg. No. 1055.
Station 100+10±, range 30' U/S. Look downstream
Lt. Abut. Sand filter in background.



127. Longview Lake, 14 Sep 81, Neg. No. 1085.
Station 100+15. Look west Pleasanton zone A
sandstone.



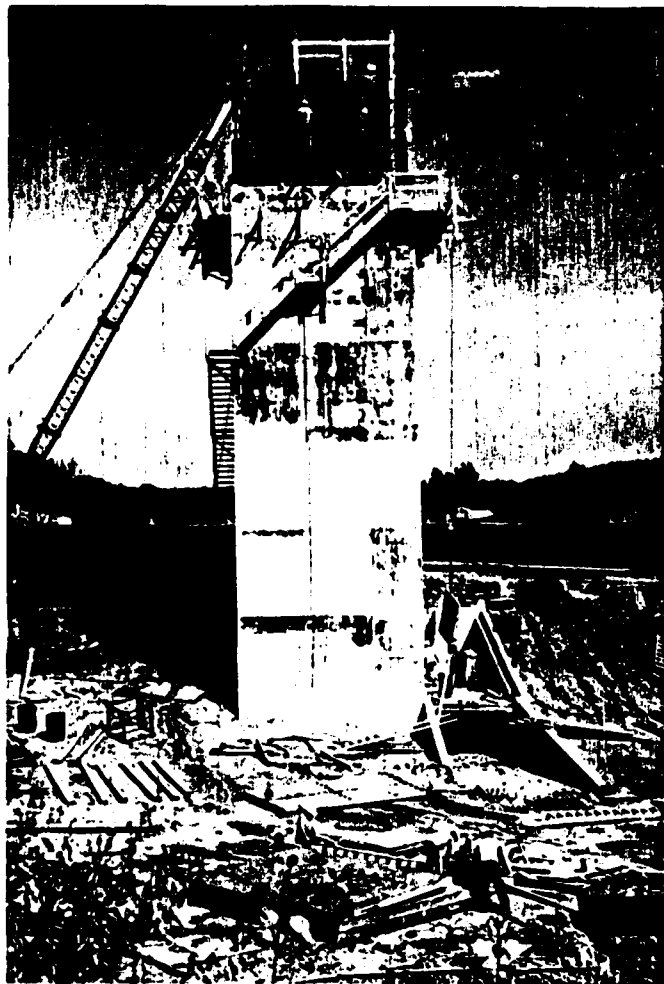
128. Longview Lake, 14 Sep 81, Neg. No. 1086.
Station 100+15. Look west Pleasanton zone A
sandstone.



129. Longview Lake, 20 Sep 81, Neg. No. 1107.
Station 100+20. Look west at Sniabar limestone,
Mound City shale and Critzer limestone.



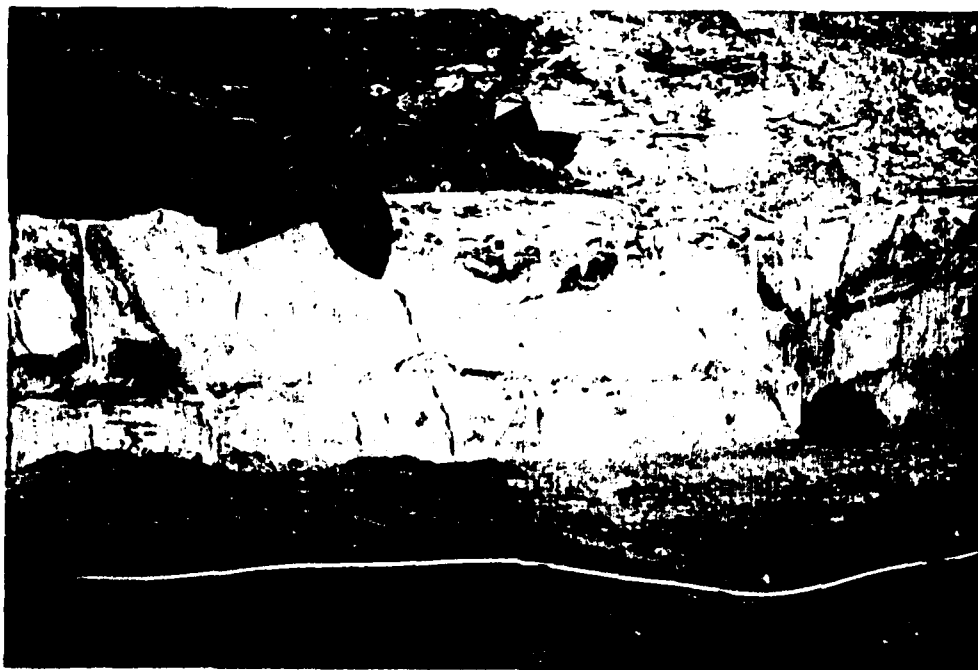
130. Longview Lake, 20 Sep 81, Neg. No. 1108.
Station 100+15. Look southwest at top of
Critzler limestone.



131. Longview Lake,
21 Sep 81, Neg. No. 1111.
Look downstream intake
tower.



132. Longview Lake, 23 Sep 81, Neg. No. 1117.
Station 100+50. Look west Sniabar limestone fill
concrete U/S side of cutoff trench.



133. Longview Lake, 23 Sep 81, Neg. No. 1118.
Station 100+50. Look west Sniabar limestone.



134. Longview Lake, 30 Sep 81, Neg. Ne. 1131.
Station 100+75. Look upstream Middle Creek
limestone.



135. Longview Lake, 2 Oct 81, Neg. No. 1132.
Station 100+75. Look downstream slickensides in
Ladore shale.



136. Longview Lake, 3 Oct 81, Neg. No. 1136.
Station 100+60, range 200' U/S. Look upstream.



137. Longview Lake,
4 Oct 81, Neg. No. 1137.
Station 100+75, range
100' U/S. Filling joints
in Middle Creek limestone
with grout.



138. Longview Lake, 4 Oct 81, Neg. No. 1140.
Station 100+70, range 200' U/S. Look upstream
compacting fill against Middle Creek limestone.



139. Longview Lake, 19 Oct 81, Neg. No. 1157.
Station 101+00. Look west at Bethany Falls
limestone.



140. Longview Lake, 5 Nov 81, Neg. No. 1193.
Station 101+70. Look D/S. Sand filter along
top of Bethany Falls limestone.



141. Longview Lake, 27 Nov 81, Neg. No. 1216.
Station 101+60. Look west at Bethany Falls
limestone. Tarps cover Stark-Galesburg shale.
Above, the Bethany Falls.



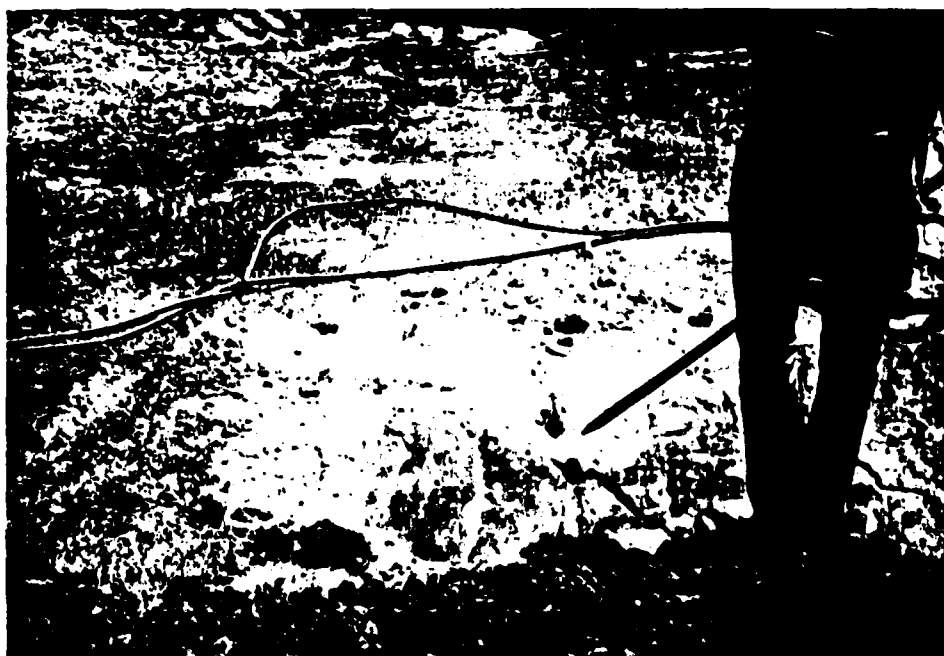
142. Longview Lake, 28 Nov 81, Neg. No. 1217.
Station 102+00. Look D/S at top of Bethany Falls
limestone.



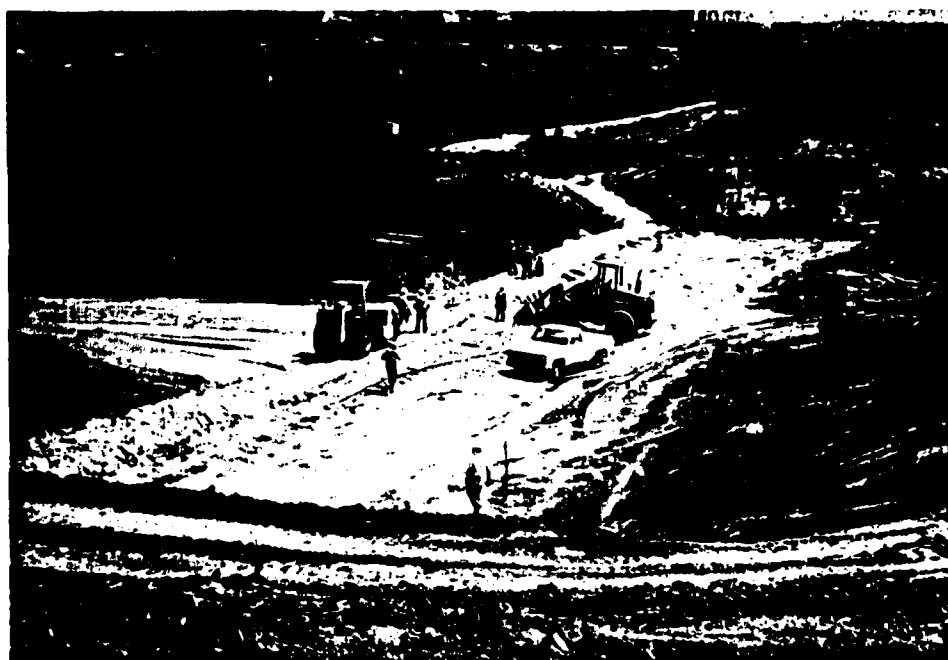
143. Longview Lake, 29 Nov 81, Neg. No. 1221.
Station 102-30. Look west at Stark-Galesburg Shale.



144. Longview Lake, 9 Jul 83, Neg. No. 157.
Camera at Station 98+00, range 216' U/S. Look
northeast at closure area (94+60 to 95+10). Right
abutment in background.



145. Longview Lake, 9 Jul 83, Neg. No. 158.
Station 95+30. Look east. Cleanup of Pleasanton
zone D in closure area.



146. Longview Lake, 15 Jul 83, Neg. No. 160.
Camera at Station 96+00±. Look northeast at
closure area.



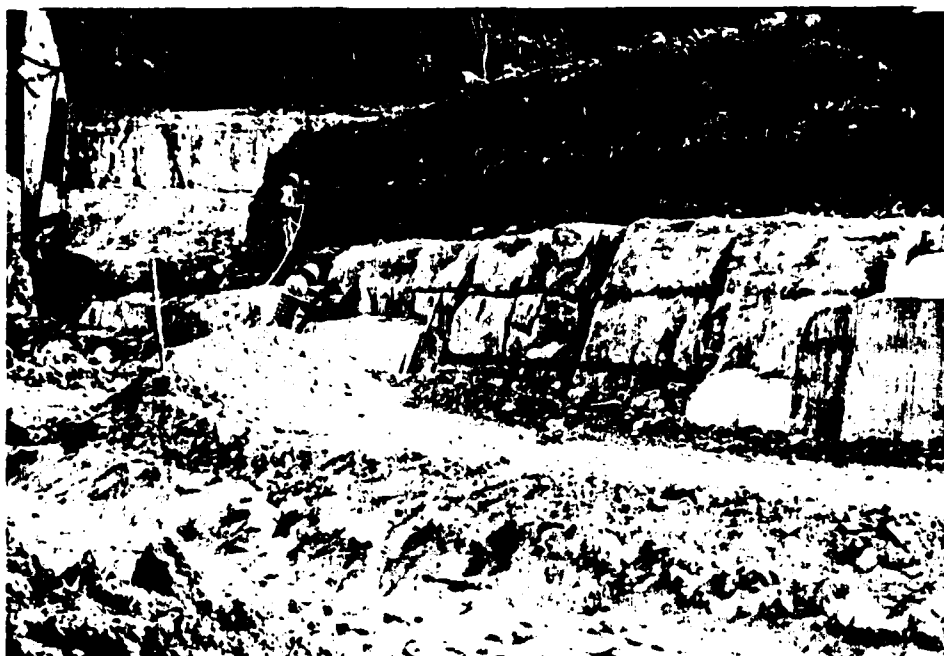
147. Longview Lake, 15 Jul 83, Neg. No. 161.
Camera at Station 94+85±. Look D/S. Placing
pervious blanket in closure area downstream plug.



148. Longview Lake, 18 Aug 83, Neg. No. 179.
Station 88+50, range 320' D. Look U/S. Joints
in Pleasanton zone A sandstone. Strike N 12°E,
spacing 3'±.



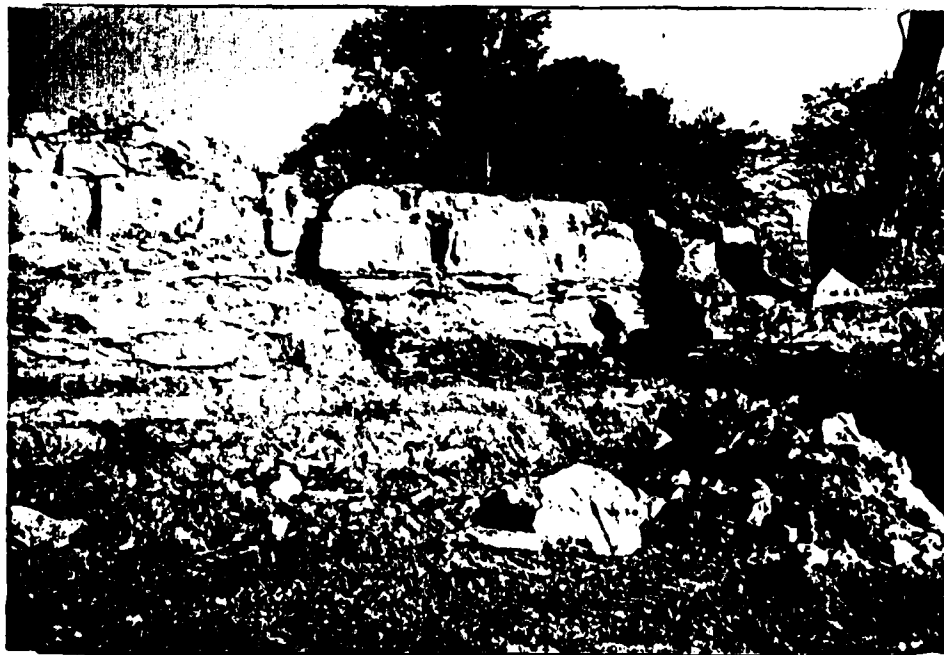
149. Longview Lake, 13 Sep 83, Neg. No. 187.
Station 88+90±, range 200'± D. Look U/S lean
concrete placed against Sniabar limestone.



150. Longview Lake, 13 Sep 83, Neg. No. 188.
Station 88+90±, range 200'±D. Look D/S lean
concrete placed against Sniabar limestone.



151. Longview Lake, 6 Oct 83, Neg. No. 206.
Station 102+00. Look downstream at Winterset
limestone.



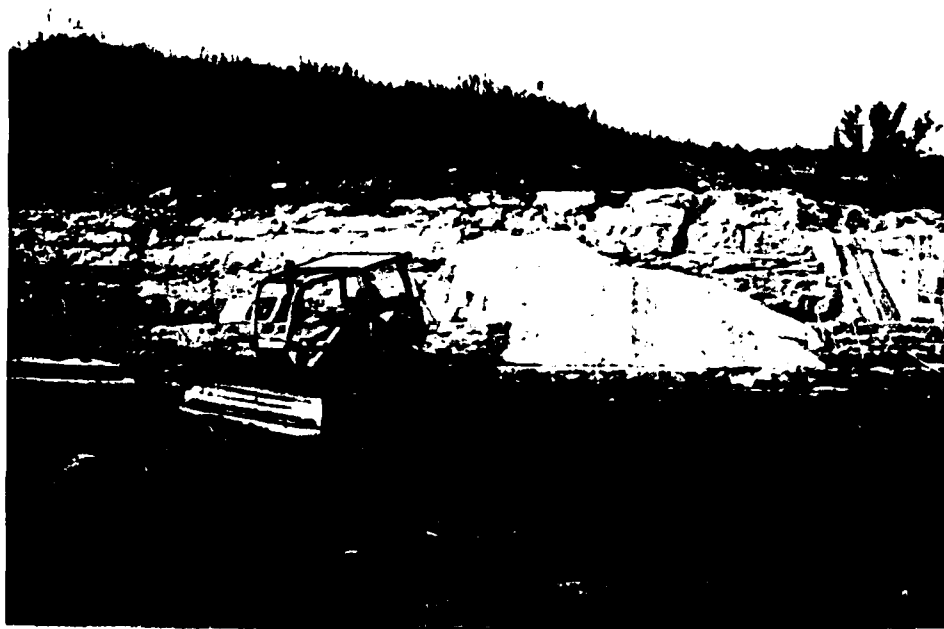
152. Longview Lake, 6 Oct 83, Neg. No. 207.
Station 102+00. Look downstream at Winterset
limestone.



153. Longview Lake, 7 Oct 83, Neg. No. 208.
Station 101+50, range 50'±D. Look west at
Winterset limestone downstream wall of cutoff
trench.



154. Longview Lake, 14 Nov 83, Neg. No. 222.
Station 102+10, range 50'±D. Look west at
Winterset limestone downstream wall of cutoff
trench.



155. Longview Lake, 14 Nov 83, Neg. No. 223.
Station 102+10, range 50'±D. Look west at
Winterset limestone downstream wall of cutoff
trench.



156. Longview Lake, 14 Nov 83, Neg. No. 224.
Station 102+10, range 50'±D. Look west at
Winterset limestone downstream wall of cutoff
trench.



157. Longview Lake, 14 Nov 83, Neg. No. 225.
Station 101+90. Look west at Winterset limestone.



158. Longview Lake, 14 Nov 83, Neg. No. 226.
Station 102+10. Look west at Winterset limestone.
Upstream wall of cutoff trench.



159. Longview Lake, 14 Nov 83, Neg. No. 227.
Station 102+25. Look west at Winterset limestone.
Upstream wall of cutoff trench.



160. Longview Lake, 14 Nov 83, Neg. No. 229.
Station 102+25. Look west at Winterset limestone.



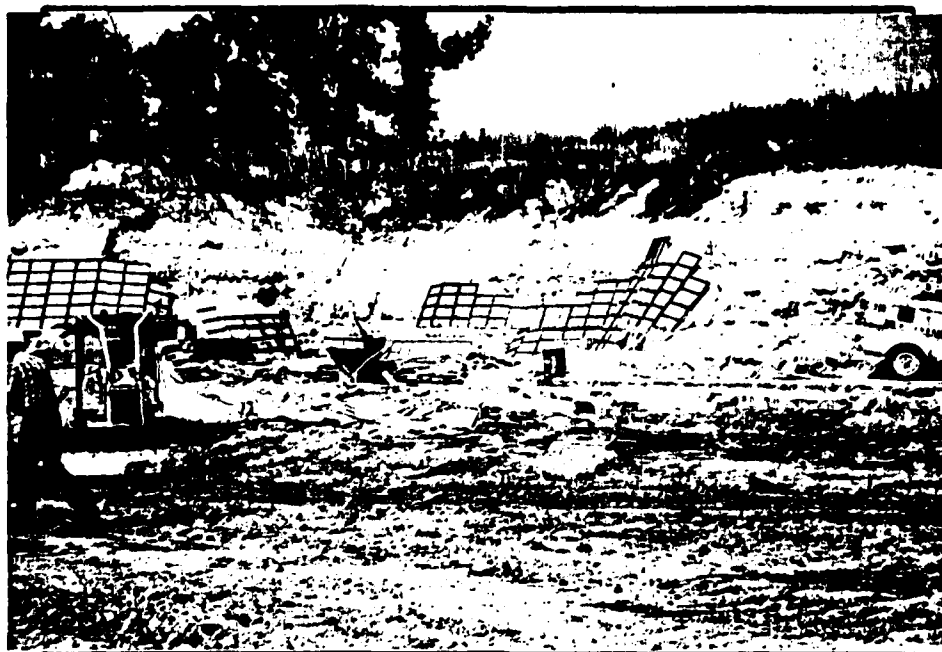
161. Longview Lake, 9 Jul 84, Neg. No. 267.
Station 87+50. Look at upstream wall of cut or
trench. Stark-Galesburg shale.



162. Longview Lake, 17 Jul 84, Neg. No. 271.
Station 85+95±. Look west at top of Winterset
limestone.



163. Longview Lake, 18 Jul 84, Neg. No. 272.
Station 87+50. Look downstream at Stark-Galsburg
shale.



164. Longview Lake, 31 Jul 84, Neg. No. 273.
Station 87+30. Look downstream at Winterset
limestone.



165. Longview Lake,
31 Jul 84, Neg. No. 275.
Station 87+301, range
60'±UP. Look downstream
at Stark shale.



166. Longview Lake, 6 Aug 84, Neg. No. 277.
Station 103+00. Look west at Block limestone.



167. Longview Lake, 6 Aug 84, Neg. No. 278.
Station 103+00. Look west at Block limestone.



168. Longview Lake, 16 Dec 82, Neg. No. 13.
Clay blanket area. Look east at Bethany Falls
Slide Block.



169. Longview Lake, 16 Dec 82, Neg. No. 23.
Clay blanket area. Look E. S. E. at Bethany Falls
Slide Block.

END

11-87

DTIC